GOVERNMENT OF INDIA
CENTRAL MARINE FISHERIES RESEARCH INSTITUTE, MARINE FISHERIES P.O., MANDAPAM CAMP, SOUTH INDIA

ANNUAL REPORT OF THE DIRECTOR FOR THE YEAR ENDING 31st MARCH 1962

CONTENTS

I. Administrative and General

Steady progress was maintained during the year 1961–62 in the implementation of the various programmes of work under the normal and Five-Year Plan Schemes both at the Headquarters and the different subordinate establishments of the Institute. A new research centre was established at Port Blair (Andamans) for the study of the Fishery resources of the Andaman and Nicobar areas. The research work carried out at the Institute was reviewed by Dr. C. F. Hickling, Fisheries Expert from U.K. during the year.

The total landings of marine fish during 1961 were 683,569 metric tons as against 879,681 metric tons in 1960, though this figure exceeds the average for the period 1950-1960 by 27,000 metric tons.

Volume VII, No. 2, of the *Indian Journal of Fisheries* was published during the year.

The Budget Allotment for the year under the heads "recurring" and "non-recurring" amounted to Rs. 15,81,000 and Rs. 3,50,000 respectively.

Among the important items of capital works that were completed during the year, mention could be made of the renovation and extensive repairs to some of the laboratory blocks at the Research Institute. Work on the construction of 12 Units of Class IV staff quarters is in progress.

The annual requirements of scientific equipment and materials were duly purchased and made available to the scientific workers. The Ministry sanctioned some foreign exchange allotment for purchase of scientific equipments required in connection with our participation in the International Indian Ocean Expedition and indents for these equipments were placed with the D.G.S. and D.

The Library of the Research Institute was considerably augmented with the acquisition of some rare and new books and publications, maps, etc., and by increasing the number of periodicals subscribed for. Considerable additions were made also by exchange of publications for the *Indian Journal of Fisheries* amd also our "Reprints" (Scientific Papers published by staff members); though requests for exchange facilities with our Journal are constantly on the increase, in view of the limited quota prescribed for exchange and free distribution of the Journal, a number of requests could not be fulfilled. A list of research publications from the Institute during the year is given at the end of the report.

The following appointments of Assistant Research Officers were made during the year:

Shri K. Radhakrishnan Dr. R. Prasanna Varma Shri V. M. Deshmukh Shri V. Rammohana Rao Shri A. S. Kaikini	On stop gap basis

Shri G. G. Suralkar, Administrative Officer in this Institute, was transferred to the Central Institute of Fisheries Education, Bombay, during the year and in his place Shri D. C. Ganpati was appointed Administrative Officer.

Fifty-six members of Class II, III and IV staff in the Institute have been confirmed against vacant posts converted into permanent ones with effect from 17–12–1960. Twenty-two temporary staff members were declared quasi-permanent during the year. Miss Mary Samuel, permanent Assistant Research Officer in this Institute, was confirmed in the post of Research and Investigation Officer in the Ministry of Food and Agriculture.

Shri M. Krishna Menon, Research Officer (Junior), retired from service on attaining superannuation, on the termination of extension of service granted to him for one year with effect from 13–1–1961. Dr. S. V. Bapat, Assistant Research Officer, who is holding permanent appointment in this Institute, was relieved of his duties here to take up appointment under the Deep Sea Fishing Station, Bombay.

Dr. R. Raghu Prasad, Research Officer (Senior) and Shri R. Jayaraman, Assistant Research Officer, participated in the Indian Ocean Expedition Inter-Calibration Seminar held in Hawaii during the year. Dr. S. Jones, Director, participated in the discussions at Delhi for finalising the III Five-Year Plan proposals of the Institute. He also attended the standing Fisheries Research Committee meeting and Gear Technologists Conference at Veraval and the Kerala State Fisheries Research Committee Meeting at Trivandrum.

Dr. S. V. Bapat, Shri M. J. George and Dr. R. Prasanna Varma, Assistant Research Officers, returned from Deputation after undergoing advanced training in Canada, U.S.A. and Japan respectively during the year. Members of the Scientific staff of this Institute took active part in the Oceanographic and fish-finding cruises conducted by the Indo-Norwegian Project on board the vessel R. V. Varuna.

The number of visitors to the Institute showed an increase during the year. Among the distinguished visitors to the Institute, mention may be made of:

Shri B. Gopala Reddi, Minister for Works, Housing and Supply.

Shri F. C. Gera, Deputy Secretary to the Government of India, Ministry of Food and Agriculture (Department of Agriculture).

Shri Prem Narain, Deputy Financial Adviser to the Government of India, Ministry of Food and Agriculture (Department of Agriculture).

Shri T. N. Singh, Member, Planning Commission.

Shri J. S. Srivastava, Senior Research Officer, Planning Commission.

Mr. P. Subbiah Ambalan, Member of the Lok Sabha.

Dr. J. H. Ryther, U.S.A.

Dr. R. Rofen, U.S.A.

Dr. C. F. Hickling, U.K.

Messrs. K. Sunnana, Director-General of Fisheries, Norway and Member of the Norwegian Indian Foundation, Oslo (Leader).

S. Nybe, M.P. and Member of the Board of Directors, Norwegian Indian Foundation, Oslo, and Per Sandavan, Manager, Norwegian Indian Foundation, Oslo.

Shri H. D. Singh, General Manager, Southern Railway, Madras.

Miss Mary Samuel, Fisheries Research and Investigation Officer, Ministry of Food and Agriculture, New Delhi.

Shri M. Marlange, Institute, Frankois, Pondicherry.

Dr. (Miss) M. Chandy, Reader, University of Delhi, Delhi.

Mr. Per Myrland, Indo-Norwegian Project, Ernakulam.

The Research Scholars under the Ministry of Scientific Research and Cultural Affairs and Dr. E. G. Silas, Pool Officer of the Council of Scientific and Industrial Research attached to this Institute continued to make satisfactory progress with their researches.

The Institute continued to extend help and facilities to a number of student parties from Universities, Colleges and Schools who wanted to acquaint themselves with the research work carried out here. Facilities for study were also extended to a number of individual workers. Lectures were

given by the staff members of the Institute at Headquarters and subordinate establishments to the All-India Fishery Trainees from the Central Inland Fisheries Research Institute, Barrackpore. Facilities for study were also given to Trainees of the Fisheries Staff Training Centre, Government of Gujarat, Ahmedabad, and Staff Trainees, Department of Fisheries, Bombay. A large number of parties from the various educational institutions in the country visited the Institute.

II. Fishery Survey

The analyses of data collected in 1961 were completed during the year under review. The total landings of marine fish during 1961 were 683,569 metric tons as against 879,681 metric tons in 1960, showing a decrease of about two lakhs metric tons. It may be noted that while landings of marine fish in 1960 had been the highest since 1950, marine catch in 1961 exceeds the average for the period 1950–1960 by about 27,000 metric tons. The State-war break up of the total landings for 1961 and 1960 are given in Table I.

Table I

	State	Fish landings in metric tons	
		1961	1960
1.	West Bengal and Orissa ..	8,924	5,532
2.	Andhra ..	54,506	56,720
3.	Madras ..	1,23,501	1,07,810
4.	Kerala ..	2,67,493	3,44,605
5.	Mysore ..	17,248	1,00,557
6.	Maharashtra ..	1,11,839	1,27,172
7.	Gujarat ..	91,396	1,27,982
8.	Goa ..	452	1,439
9.	South Andamans ..	131	129
10.	Laccadive Islands ..	872	509
11.	Trawlers ..	7,207	7,226
	Total ..	6,83,569	8,79,681

It will be seen from Table I that while West Bengal, Orissa and Madras registered an increase in landings, a significant fall in catches was recorded in Mysore, Gujarat and Kerala. A slight fall in the total landings was also noticed in Maharashtra. A successful fishery in Contai (Midnapore District) along with heavy landings in South Orissa during the

third quarter of 1961 augmented the total catch of West Bengal and Orissa by 3,392 metric tons. This was mainly due to increased landings of Clupeids, prawns and *Leiognathus* and *Gazza.*

In Andhra, landings were more or less of the same order as those of last year. An increase in respect of landings of elasmobranchs, seerfish, ribbon-fish, penaeid prawns, eels and *Chirocentrus* was noticed in this state, but this increase was offset by decreased landings of *Anchoviella*, mackerel, *Leiognathus* and *Gazza*, pomfrets, red mullets, *Thrissocles* and crustaceans.

In Madras unfavourable weather and strong current in the sea during the second quarter of 1961 affected the flying fish fishery adversely resulting in reduction in the landings by about 5,000 metric tons. A decrease was also recorded in the catch of ribbon-fish, sardines and *Anchoviella.* But a comparatively good fishery in North Madras and Gulf of Mannar regions during the Third quarter of 1961 showed improved catches of *Caranx*, mackerel, perches, sciaenids, seer fish, tunnies, clupeids and elasmobranchs and brought about an increase in the overall landings in Madras.

Due to the protracted S.-W. monsoon all along the West coast, the fishing season started late in all the maritime States of West coast as a result of which there were less number of fishing days in the calender year 1961 for almost all the States. This accounted for, in a general way, the decline in the total landings in these States during 1961.

In Kerala, the oil sardine fishery was comparatively good. But due to late commencement of the fishery in the State due to prolonged monsoon, a shortfall of about 20,000 metric tons (*i.e.*, about 10%) was noticed in the landings of 1961. Mackerel fishery in the State was, however, very poor, resulting in a fall of 15,000 metric tons (*i.e.*, about 44%) in the landings of the fish. Reduction in catches of other sardines, *Anchoviella*, soles, *Caranx*, *Lactarius, Thrissocles* and other clupeids was also noticed. In contrast to this decline, some increase in the landings of penaied prawns, ribbon-fish, and elasmobranchs was, however, noticed in this State during the year.

In Mysore, the protracted monsoon delayed the commencement of the fishing season in 1961, and even when it commenced, there were almost no mackerel shoals in the inshore waters. This caused total failure of mackerel fishery which forms the mainstay of the commercial catch in the state. Mackerel alone accounted for a fall of 75,000 metric tons. Some decline was also noticed in the landings of sardines, cat fish, *Anchoviella*, *Lactarius* and seer fish.

In Maharashtra, there was some increase in the total landings of eels, sciaenids, perches and pomfrets; however, the decrease in the landings of Bombay duck, cat fish, *Bregmaceros* and prawns caused an overall decline in the total landings in the State. Mackerel fishery was also a failure in the Southern region of the State. The main reason for this small decline may be attributed to the late commencement of the fishing season in this State also during 1961.

In the first quarter of 1961, even though appreciable increase in the Bombay duck landings was noticed in the Jaffrabad-Rajpara area, heavy decrease elsewhere in Gujarat in respect of landings of elasmobranchs, polynemids, pomfrets, *Hilsa* and sciaenids resulted in a decline of about 5,000 metric tons in the total landings. In the second quarter of 1961 due to inclement weather conditions prevailing in parts of Gujarat and also due to early cessation of fishing activity by the migrant fishermen in Jaffrabad area, the total landings suffered a decline of nearly 10,000 metric tons. In addition to these reverses, the Bombay duck fishing season in Jaffrabad area, which commenced in September in 1960, did not commence till October in 1961 mainly due to adverse weather conditions . This late commencement of the fishery caused a shortfall of nearly 12,000 metric tons during the year 1961, even though from the general trend of the fishery, it appears that the total landings in 1961–62 season may equal that in 1960–61 season.

Table II shows the overall composition of the total marine fish landings in India during 1961. For comparison, the corresponding figures of 1960 are also given.

Table III shows the seasonal variations in the catch landed in different maritime States of India. It will be seen from the table that 40% of the landings were made during the last quarter of the year. Excepting Andhra, Madras and Mysore, the bulk of landings was made in the fourth quarter. In Andhra the highest landings were obtained during the first quarter. This was due to successful fishery in North Andhra. In Madras, third quarter landings were the highest. The failure of mackerel fishery affected the fourth quarter landings adversely in Mysore.

Catch per unit of effort.—Table IV shows the total effort in man-hours expended in each State and also the catch per effort expressed in kilogramme. The corresponding figures for 1960 are also shown for comparison.

TABLE II

Composition of marine fish landings

Name of fish	Quantity landed in metric tons	
	1961	1960
1. Elasmobranchs ..	33,554	35,569
2. Eels ..	11,380	6,140
3. Cat fishes ..	10,928	25,041
4. *Chirocentrus* ..	6,748	5,320
5. (*a*) Oil sardine ..	1,67,884	1,89,016
(*b*) Other sardines ..	19,764	32,003
(*c*) *Hilsa ilisha*	1,050	3,345
(*d*) Other Hilsa ..	6,475	8,443
(*e*) *Anchoviella* ..	22,103	35,885
(t) *Thrissocles* ..	4,962	7,522
(*g*) Other clupeids ..	15,256	20,654
6. (*a*) *Harpodon nehereus* ..	93,844	1,08,564
(*b*) *Saurida* ..	865	482
7. *Hemirhamphus and Belone* ..	493	213
8. Flying fish ..	1,206	6,470
9. Perches ..	15,377	9,804
10. Red mullets ..	2,165	2,568
11. Polynemids ..	5,920	6,649
12. Sciaenids ..	29,917	24,947
13. Ribbon-fish ..	19,515	17,467
14. (*a*) *Caranx* ..	22,551	21,583
(*b*) *Chorinemus*	3,517	4,212
(*c*) *Trachynotus* ..	7	9
(*d*) Other carangids ..	113	154
(*e*) *Coryphaena* ..	138	228
(*f*) *Elacate* ..	185	272
15. (*a*) *Leiognathus*	15,763	15,760
(*b*) *Gazza* ..	201	634
16. *Lactarius* ..	8,898	14,501
17. Pomfrets ..	16,488	21,850
18. Mackerel ..	34,485	1,33,655
19. Seer fish ..	11,449	8,650
20. Tunnies ..	7,805	5,615
21. *Sphyraena* ..	1,389	1,985
22. *Mugil* ..	862	912
23. *Bregmaceros* ..	3,900	6,096
24. Soles ..	7,730	14,107
25. (*a*) Penaeid prawns ..	39,083	31,759
(*b*) Non-penaeid prawns ..	23,685	36,271
(*c*) Other crustaceans ..	2,038	2,571
26. Cephalopods ..	94	467
27. Miscellaneous ..	13,782	12,288
Total ..	6,83,569	8,79,681

TABLE III

Seasonal variations in catch

(Figures in metric tons)

States	Period				
	I Quarter	II Quarter	III Quarter	IV Quarter	Total
West Bengal and Orissa	2,588	937	1,688	3,711	8,924
Andhra ..	16,871	11,199	12,397	14,039	54,506
Madras ..	21,434	21,295	59,196	21,576	1,23,501
Kerala ..	87,760	40,881	47,131	91,721	2,67,493
Mysore ..	1,893	684	1,399	13,272	17,248
Maharashtra ..	28,076	22,313	6,981	54,469	1,11,839
Gujarat ..	10,529	6,358	2,587	71,922	91,396
Total ..	1,69,151	1,03,667	1,31,379	2,70,710	6,74,907
Percentage ..	25·06	15·36	19·47	40·11	

TABLE IV

Total effort in man-hours and catch per effort in kilogrammes

States	Effort in 1,000 man-hours		Catch per man-hour in kg.	
	1961	1960	1961	1960
1. West Bengal and Orissa	5,895	7,182	1·51	0·77
2. Andhra ..	46,138	48,548	1·18	1·17
3. Madras ..	68,713	66,849	1·80	1·61
4. Kerala ..	37,869	39,972	7·06	8·62
5. Mysore ..	5,702	9,879	3·02	10·18
6. Maharashtra ..	20,876	23,228	5·36	5·47
7. Gujarat ..	24,654	20,615	3·71	6·21
8. All-India total ..	2,09,847	2,16,273	3·22	4·02

Table IV shows that both the total effort and catch per unit effort during 1961 are less than those in 1960. While catch per unit of effort registered improvement in East Coast of India, a decrease has been witnessed in West Coast.

III. Fishery Biology

1. *The Oil Sardine*, Sardinella longicaps *and other Clupeoids*

At Karwar.—A total quantity of 29,641·39 kg. of oil sardine were landed during the year of which 26,830·15 kg. were landed by *Rampan*, 1,480·81 kg. by cast nets and 1,330·43 kg. by *Yendi*. The catch per unit of effort of these three gears *Rampan*, cast nets and *Yendi* were 3·70, 2·65 and 0·67 kg. respectively. The fishery was constituted by oil sardine in maturity stages I and II. The percentage composition of males and females in the samples studied during the season was 50·93 : 49·06. The bulk of the catches belonged to the 120 mm. size group (1 + year group) as against 165 mm., 140 mm. and 165 mm. during 1960–61, 1959–60 and 1958–59 respectively. The dominant size groups recorded at other centres along the North Kanara coast were more or less the same as that of Karwar.

The fishery for *Pedi* (*Sardinella fimbriata*) was a failure. Stray individuals ranging in size from 135–152 mm. in the maturity stages II, III and IV were recorded from *Rampan* hauls in Chendia. A few spent fish were also netted.

The oil sardine seemed to feed mostly on zooplankters such as *Acrocalanus longicornis, Eutterpina acutifrons* and *Corycaeus giesbrechti*. Diatoms and dinoflagellates were sparsely represented in the gut contents.

At Mangalore.—An important feature of this year's oil sardine fishery in the Mangalore zone was its concentration in a 15-mile section, between Ullal and Suratkal. There was intense shoaling by oil sardine in the 6–15 metre region off this stretch of the coast, especially from November–February. During an echo-survey conducted in February on board R. V. Varuna off Mangalore-Calicut region, traces of oil sardine shoals were observed within the 25 metre region in certain sections.

At Ullal the fishery was fairly good, the total estimated catch of oil sardine being 445 metric tons as against 78 metric tons during the previous year. The season started on 3rd August. Among the different gears operated, *Rampani* landed about 355 metric tons and the other nets, namely, cast nets, *Çhala bale* (gill nets) and *Kolli bale* (boat-seine) landed about 90 metric tons.

The monthly catches showed peaks in October, December and February, the cast net catches accounting for the October peak and *Rampani* for the December and February peaks. Both in regard to catch and catch per unit of effort *Rampani* ranked first, followed by *Kolli bale*. *Rampani* was operated in the 5–7 metre area and *Kolli bale* in the 5–14 metre area.

Three phases could be seen in regard to the age composition both at Ullal and other centres. (1) During August and September, the fishery was supported almost exclusively by two-year olds. (2) They were absent in the catches of October and November. The October fishery was composed of zero- and one-year old groups, while the November fishery was almost entirely of one-year-olds. (3) From December onwards, one- and two-year-olds were present, the former being the dominant group up to February. But during this period, two-year-olds were increasing in numbers, and formed the dominant group in March. At Ullal one-year-olds formed about 87% of the numbers landed by *Rampani* and about 92% of the numbers landed by *Kolli bale* over the August-March period. The average annual male to female ratio was 44 : 56. In April, oil sardine were mostly in maturity stages II and III. The two-year-olds were in Stage IV to V in August and September; a few spent ones were also recorded during this period. From October to March oil sardine were mostly immature (Stages I and II). A gross qualitative study of the stomach contents showed that food consisted mainly of the diatoms *Coscinodiscus*, *Fragilaria*, *Biddulphia*, *Pleurosigma* and *Thalassiothrix*.

At Cannanore.—The oil sardine fishery during the year was very moderate and the estimated total catches amounted to 2,776·48 metric tons, of which 67·46 metric tons, 119·82 metric tons, 845·3 metric tons and 1,743·9 metric tons were landed during the first, second, third and the last quarters respectively. The gears operated were *Arakolli vala* and *Mathikolli vala* (boat-seines).

During the first quarter the fishery was supported by oil sardine in Stages II and III with dominant size group at 150 mm. and 57% of them were females. The mode was at 160 mm. in the second quarter, and females formed 64%. Besides individuals in Stages III, IV and V, partly and completely spent males and females were landed during August and September, while in October they revealed recovering gonads. They disappeared from the catches in November, but appeared again as recovered (Stage II) in the middle of December. Their dominant size group was at 160 mm. during the last quarter also, when the sexes were equally distributed.

The bulk of the catches of the year (84%) was made up of young ones and juveniles which were recruited into the fishery from September 1961 onwards. At the outset the dominant size group was at 80 mm., while during the third quarter it shifted to 115 mm. Further growth was registered towards the end of the year, with the mode at 120 mm.

The shoals were feeding normally. Among the Bacillariophyceae, *Coscinodiscus*, *Fragilaria oceanica*, *Thalassiothrix*, *Thalassiosira*, *Pleurosigma* and *Biddulphia* were favoured, while among the Dinophyceae, *Dinophysis caudata*, *Prorocentrum micans*, *Pyrophacus*, *Ceratium* and *Peridinium* were commonly fed. *Evadne tergestine*, the more common copepods, nauplii, various species of *Tintinnopsis*, and larval bivalves were the important zooplankters fed by the oil sardine.

At Kozhikode.—The oil sardine fishery was fairly good and the total landings amounted to 7,988·66 metric tons as compared to 7,677·89 metric tons in 1960–61 and 1,561·16 metric tons in 1959–60. The highlight of the oil sardine fishery during the year was the entry of juveniles ranging in size from 50–84 mm. with a modal size of 65 mm. in August. These juveniles had continued to occur in large numbers in September also. During the rest of the year, the second year class (110–129 mm.) had contributed to the bulk of the catches. Among the different gears operated *Kolli vala* and *Thattum vala* accounted for 79·11% (6,320·07 metric tons) and 14·92% (1,192·26 metric tons) respectively of the total quantity landed during the year. The highest annual catch per unit of effort was recorded by *Thattum vala* (10·1 kg.) which was closely followed by *Kolli vala* (9·21 kg.). In general, the values for the catch per unit of effort of the different gears during the season were fairly good as compared to the previous year's figures. Certain notable features concerning the fishery during the year were: (*a*) the occurrence on a large-scale of the first year class in August and September when usually third year class has been found to dominate, and (*b*) the occurrence of small sized oil sardine (110–125 mm.) belonging to the second year class for September to March, as against the 130–150 mm. group which normally supports the fishery during these months. It is likely that either this year's second year class had not attained their normal size owing to scarcity of food, or the stock of oil sardine which had entered the inshore waters this year might have belonged to an entirely different population. Fishing for oil sardine was mainly confined to the 2–10 fathom region during the year but the heaviest concentrations were in the 2–5 fathom area.

A total of 1,333 fish from 54 samples was examined during the year 1961–62 for studies on spawning and maturity. In April and May the fish

ranging in size from 140–180 mm. were mostly in Stage I while some, especially females, showed signs of further development (I–II). However, in June fish distinctly showed very rapid development of gonads to Stages II, III and IV *a* and in July evidences for the spawning season having started were available, as the fish examined were mostly partially spent and the rest in IV–V. In August, while the females were recognised as belonging to Stages IV–V and IV *b*, males were in stages IV *b*, V and V–VI. September registered fish mostly in Stage VII and some advancing further from IV *b*. From October onwards all the bigger fish encountered above 150 mm. were completely spent and spent resting. The salient features of this year's observations are (1) evidences for earlier onset of spawning, (2) the average size of spawners in 150 mm. group unlike the previous year when the fish belonged mostly to 170 mm. group, (3) the minimum size at maturity around 155–160 mm. indicating the possibility of individual fish entering to spawning season more than once in their lifetime, (4) the conspicuous absence of indeterminate juveniles in July and their late appearance almost at the beginning of September and (5) the unusually large percentage of indeterminates even as late as February.

The possible causes leading to the incidence of vascular hypertrophy accompanied by follicular breakdown observed in ovaries slightly advanced beyond Stage IV *a* during August are being ivestigated. But for the preponderance of males in spent resting class both in January and February, the differences in the sex ratio were negligible.

Studies on 53 ovaries have revealed that at a stage between III and IV *a* two stocks of maturing ova become apparent which do not lose their identity till spawning and there are evidences in favour of fractional spawning in individual fish.

The figures obtained for 1961 season compare favourably with those obtained during 1959 and 1960 seasons on fecundity estimates. It is found that about 65 to 75% of the total number of ova maturing during the season are delimited to be spawned first.

In the stomach contents of oil sardines diatoms were represented by *Coscinodiscus* sp., *Fragilaria oceanica* and *Thalassiosira* sp. *Biddulphia* sp. and *Pleurosigma* sp. were also frequently observed. Amongst Dinophyceae, *Prorocentrum micans*, *Dinophysis caudata* and *Peridinium* sp. were dominating. *Tintinnus* sp. and copepods were the main zooplankters observed.

At Ernakulam.—The fishery for oil sardine at Manasseri was erratic throughout the year. The bulk of the catches was formed of juveniles, the

modal size of which ranged from 115–125 mm. from September to March. The catches during April–June were comprised mostly by oil sardine in maturity stages II, III and IV, whereas those landed during July and August were in Stages IV, V and a few in partly spent condition. Data collected on sex ratio indicate that females constituted 52–55% of the catches during the first three quarters and 40–46% during the last quarter.

Scales from oil sardines ranging in size from 140–195 mm. were examined. One 'ring' was seen in the scales of fish belonging to the 140–155 mm. group and two 'rings' in the 160–190 mm. group, indicating that the former had completed one year and the latter two years of their life.

At Vizhingam.—Except during the quarter July–September the oil sardine fishery at Vizhingam was poor. Out of a total of 3,690 kg. landed by gill nets and shore-seines during the year, over 70% was landed during the second quarter.

The range in size varied from 25 to 190 mm. in total length and all the fish were juveniles with either immature or indeterminate gonads. The gut contents were observed to be dominated more by phyto- than by zooplankton.

The total landings of *Sardinella fimbriata* at Vizhingam amounted to 33,205 kg. during the year. As in the previous year the bulk of the catches was landed during the first and the third quarters by shore-seines, gill nets and boat-seines. The size of the fish ranged from 25 to 185 mm. in the third quarter. During the last quarter fish from 25 to 80 mm., with the dominant size at 35 mm., appeared in the inshore waters. The fishery was mainly supported by juveniles and indeterminates. Mature and spent specimens were noticed during the first and third quarters. *Sardinella fimbriata* feeds mainly on zooplankters with copepods and other crustaceans dominating.

2. *The Mackerel*—Rastrelliger canagurta

At Karwar.—Rastrelliger fishery has completely failed along the north coast. At Karwar, the average annual landings of 1,600 tons dropped to 50·112 tons. The catch per unit of effort was the lowest ever recorded 3·29 kg. Mackerel shoals appeared late this year in inshore waters and the first rampan was operated on 26–10–1961. The season was perhaps the shortest, the total number of fishing days being only 27. It lasted hardly for two months from late October to the middle of December 1961. The fishery at the beginning of the season indicated a heterogenous group made up of two broods of very different origin. Out of the total of 7,36,630 numbers

fished 6,03,983 numbers or nearly 32% were in 180–195 mm. group. In October, the large fish in 225–235 mm. group totalled 15,495 numbers or 9·06% of the month's landings. The feeding activity was intense in April and in maturity stage III as well. The intensity of feeding as indicated by the volume of stomach contents showed alternate high and low feeding in successive size groups except in 240 mm. gfroup where it was very low. During April–August, phytoplankton elements were prominent. Dinoflagellates, Cladocerans and Copepods like *Oithona* spp., *Acrocalanus* spp., *Temora turbinata*, *Schmasckeria serricaudata* and *Euterpina acutifrons* formed the main food during the post-monsoon months. The appearance of mackerel in inshore waters depends to some extent on the availability of the food elements in the inshore plankton and one of the contributing factors responsible for the failure of mackerel fishery this year may be the scarcity of these food elements in plankton. The fishery was mainly composed of immature fish in maturity stages I and II. Larger fish totalling 17,435 in number caught in October and November had spent gonads. No segregation of sex was noticed. The ratio of male to female being 49 : 51. The yendi operations during the year yielded 422 kg. The modal size of fish was comparatively large, 225–235 mm. and were spent recovering fish. One specimen obtained on 4–8–1961 showed developing "plum-pudding" ovary with transparent ova measuring 0·714 0·816 mm. in diameter and the single oil globule measuring 0·204–0·238 mm. The diameter of transparent ova averaged 0·75 mm. and that of the oil globule 0·22 mm. In the off-season samples there was a preponderance of female fish.

This year there was very heavy rainfall. The salinity was the lowest (0·470%) recorded at Karwar. By the end of the year temperature, salinity and pH registered very high values. Salinity showed very high figures compared to the two previous years. The change from low values of monsoon period to the high ones in the summer months usually takes place in a moderate pace and there exists a transition period—September–January—during which moderate temperature, pH and salinity prevail in the inshore waters. It is during this period that mackerel appear in shoals in the coastline. This year the transition period was too short and this may be one of the reasons for the failure of mackerel fishery this season. The probable effect of the 1958–59 fishery on the present season needs mention. The season was then prolonged one up to the end of April. During the latter part of the season the fishery was constituted by large fish in 220 mm. mode. During the commencement of the fishery in 1959–60 and 1960–61 the fishery was constituted of fish above 220 mm. Catch of such potential spawners would naturally have an adverse effect on the intake of the recruits.

At Mangalore.—The mackerel fishery at Ullal and other centres in this zone was a complete failure this year. A total of 22·313 metric tons was recorded as against 81·6 metric tons of the previous year. The *Rampani* season commenced in the last week of October with catches of moderate magnitude but the fishery came to an abrupt end by the first week of November. After this, mackerel shoals were not sighted in inshore waters. Some interesting observations on the dispersal of mackerel shoals were made on board R. V. Varuna, during her cruise in Mangalore-Calicut zone, in February 1962. The horizontal and vertical echo-survey revealed traces of shoals in waters up to 20 metres depth; but beyond this range there were no traces. The farthest station worked during the survey was about 35 miles from the continental shelf. The midwater trawl was operated within 20 meter depth. Of the three hauls made, the one off Malpe landed only two mackerel. The echo-survey conducted off Karwar-Goa coasts in March and April did not show any traces of shoals up to 1,100 metres depth. The size of mackerel caught in the gill nets—*Pattabale* and *Kanthabale* was 205–239 mm. in April and May. Mackerel caught in *Pattabale* in October measured between 145–179 mm. The *Rampani* catch in October and November comprised of fish with 180–184 mm. modal size. In December and January, it was 170–174 mm. and 175–179 mm. The size group of mackerel caught in January and March in Nethravati estuary was 205–259 mm. The sex ratio of mature mackerel was almost equal in *Pattabale* catch but in *Kairampan* it was unequal. The proportion of sexes of immature individuals caught in all nets was almost equal. Maturing individuals occurred in April and May. Mature and partially spent mackerel contributed to the fishery in August–October months. Immature mackerel were recorded in September–February period. Stray specimens in spent and spent-recovery condition occurred in the Netravati estuary in January and March. The volume of food in all size groups was in general poor and much less in size groups below 210 mm. During October the cladocerans, *Evadne tergestina* and *Penilia avirostris*, were the dominant forms in the stomach contents. Copepods were, however, dominant in other months.

At Cannanore.—The mackerel fishery was a thorough failure during the year, as compared with the previous year and the total landing was estimated at 99·38 metric tons. Of this 59·78, 9·01, 28·91 and 1·68 metric tons were landed during the first, second, third and fourth quarter respectively. There was a conspicuous absence of medium-sized immature fish, in inshore fishing grounds. The main gears employed for mackerel fishery were *Ailachalavala*, *Ailakollivala* and *Arakolli* of which the gill net *Ailachalavala* was

the most successful. The size range of mackerel in the commercial landings during the first quarter was 20·5 to 23·5 cm. with dominant size at 22·5 cm. In the second quarter 98% were of the same size range and the remaining 2% were immature fish measuring 9·5–19·5 cm. The landings during the third quarter were mainly supported by 17·5–18·5 cm. group. The 22·5–24·5 cm. group rarely entered the fishery. Towards the close of the season the size range was 16·5–21·5 cm. with dominant sizes at 17·5cm. and 19·5cm. The intensity of feeding was more in the first quarter than in subsequent periods. The phyto- and zoo-plankton formed the main food constituents, their relative abundance varying according to the general composition of the plankton. The bulk of the landings comprised of maturing and mature mackerel, the immature fish being comparatively rare. On the whole the males predominated (52%) but the percentage varied from quarter to quarter. Mackerel in the first and second quarter were mostly mature and spawning (Stages IV–VII) although various size groups included Stages I–VII. The mackerel examined in the third quarter contained mostly immature fish (Stages I and II). In October the adults were in partially spent condition (Stage VI *b*) while in November spent fish (Stage VII) were encountered. In January, most of the fish were in Stage I and II and in March they were in advanced stages of maturity (Stages III and IV).

At Kozhikode.—Mackerel landings for 1961–62 were the lowest since 1957. A total of 377·957 metric tons were landed which is far below the seasonal average of 850 metric tons for the last five years. The total landings for the fiscal year were 476·078 metric tons. There were no mackerel landings during July 1961 and February 1962. During April–June months, the mackerel fishery in general was better compared to the corresponding period of last year, when a few specimens were caught occasionally. The total landings in the next quarter fell to 51·493 metric tons. In October and November the fishery was good at Kozhikode compared with other fishing centres on the west coast. The season almost came to a close by the end of January, the total for that month being 32·089 metric tons. The operations of one boat seine *Pattenkolli* alone yielded as much as 349·954 metric tons. Of this 32·320 metric tons were night catches. The catch per-man-hour for this net varied from 2·567–17·332 kg. and the catch/fishing unit ranged from 266·23–885·778 kg. The mackerel gill net—*Ailachalavala* and the boat seine *mathikolli* landed 58·912 metric tons and 56·859 metric tons respectively.

One peculiar feature of the fishery of this season is that the commercial landings comprised juvenile, medium sized 15–17 cm. group which is usually

common during August–September months. This group normally disappears from fishery in the ensuing months—October–November and is replaced by a larger 18–21 cm. group. The continuance of the smaller group throughout the season is of significance. At the beginning of the season in October, the dominant size group was 16·5 cm. which increased to 17·5 cm. and this group persisted till the end of December. In January 1962, it was 18·5 cm. From April to September with the exception of August, large fish 21·3–23·8 cm. with 22·5 cm. as the dominant group were caught in small numbers.

Examination of the stomach contents of mackerel showed broadly the usual pattern. The fishes examined ranged from 7·2–23·1 cm. Stomachs generally indicated good feeding. Copepods were the main food constituent throughout the year. *Labidocera*, *Acartia* and *Temora* formed a major part of food in early half of the year and *Temora*, *Labidocera* and *Eucalanus* in the later half. Cladocerans did not form a dominant group as in the previous years. *Evadne* and *Penilia* were both encountered in significant numbers in the latter half of the second quarter. Other items of food included crustacean eggs, *Lucifer*, tintinnids, bivalve larvae. Fish eggs were rarely seen in the stomach of mackerel obtained in October. A large number of fish scales were observed in one sample in December. *Pleurosigma* and *Coscinodiscus* were the most abundant diatoms.

Mackerel catches and temperature and salinity of the inshore waters of this coastline show marked fluctuations from year to year. Observations show a higher susceptibility of mackerel towards temperature variations compared to salinity and their combined effect appears to be comparatively high. High tolerance towards the increase in temperature and salinity was found in bigger size groups (19–21 cm.). One of the criteria of good mackerel season appears to be that the degree of variations of temperature and salinity should be least within the tolerance ranges of these two hydrographical factors. The complete failure of the 1959–60 and 1961–62 season coincided with high pH and low hydrographical factors suggesting that higher pH may have an added effect to the fishery. Rainfall appears to have an adverse effect on the fishery and is reflected in the temperature and salinity. especially in the surface salinity. The failure of mackerel fishery in 1959–60 and 1961–62 season coincided with unusual heavy rainfall in 1959 (428 cm.) and 1961 (496 cm.). The wind force is not a decisive factor but it does indicate in a general way the trend of the fishery in correspondence with wind force. Mackerel do not appear to be particularly attracted to the fishing area for food. The concentration of mackerel shoals in inshore waters as

a direct response to plankton production has not been established. It is reasonable to assume that provided the fish is not attracted to the fishing area entirely for food in the months of maximum catches, the hydrographical conditions may be responsible for the abundance of mackerel in inshore waters.

At Vizhingam.—The mackerel fishery declined considerably during the year and the total landings were less than 50% of the previous year. The respective landings for 1960–61 and 1961–62 were 42,391 and 13,343 kg. The setback in fishery may be attributed to the failure of the larger size fish above 22 cm. contributing to the fishery. In the last quarter, only 85 kg. were landed. Shore seines, drift nets and boat seines were employed in the fishery. The hooks and lines which caught small quantities of mackerel in 1960–61 were not operated this year. The commercial catches were supported by fishes in the size range of 3·5–27 cm. During the first quarter, the size range was 6–27 cm. with two distinct modes at 13·5 cm. and 22·5 cm. In the second quarter, fish measuring 4–24 cm. entered the fishery with modes at 6 cm. and 13 cm. In the third quarter, three separate groups, 3·5–7·5 cm., 10·5–14 cm. and 19·5–24 cm., appeared. No samples were available in the last quarter. Both phytoplankton and zooplankton organisms were observed in the stomach contents. These included copepods, other crustaceans, *Alima* larva, *Cypris* larva, *Skeletonema costatum*, *Thalassiothrix*, *Nitzschia* and *Thalassionema*. Majority of the specimens were indeterminants but a few were in maturity stages I, II and VII.

At Porto Novo.—Mackerel fishery during the year was poor. A total of 4833·14 kg., roughly one-fourth the landings of the previous years, was landed. However, the mackerel season which has just started appears to be promising. Of the 4833·14 kg., mentioned above 2,612·39 kg., were caught in March 1962. The size composition of mackerel caught at the commencement of the fishery—April–June 1961 ranged between 180–200 mm. and this gradually decreased as the season advanced. By September the modal size was 160 mm. The spawning activity of the population appears to have continued during the entire period from 1961 summer to the summer of 1962. The disappearance of mackerel from the area appears to be related with the monsoon conditions. The summer mackerel season comes to a close invariably when the South-West monsoon sets in and the August–September mackerel season ends with the onset of N.-E. monsoon. Both these monsoons were a near failure during 1961 on this coast and this coincided with continuous appearance of mackerel in this area.

3. *Prawns and Lobsters*

At Kandla.—The prawn fishery of the inshore areas of Kutch is largely seasonal. The principal fishery constituted by *Metapenaeus monoceros* with the dominant size at 86–90 mm. is during August to middle of October, the estimated total yield being 700 metric tons. This fishery appears to be directly related to the amount of rainfall. In this year as well as 1959 when the salinity of the water ranged from 12·42 to 28·20‰ during the monsoon the fishery was quite good whereas in 1960 when the salinity remained high between 34·21 and 43·67‰ the fishery completely failed. The presence of juveniles of the species in the creeks during October to June seems to indicate that they migrate into these creeks at quite small size and after a period of growth with the outbreak of rain migrate into the sea. The main fishery is during this return migration. Males are found to attain maturity in the creeks while females do so only in the deeper waters. It is inferred that (1) the breeding period is during September to March, (2) the females do not attain maturity during the first year of life, doing so only after reaching a size more than 125 mm. and (3) they spawn more than once during their lifetime. The distribution of the species seem to be related to the nature of the bottom.

The winter fishery in the inshore areas of the open Gulf occur during November–February, the estimated total landings being 50 to 70 metric tons. The species caught is *Metapenaeus brevicornis* with the dominant size at 76–90 mm. Towards the end of the season females dominate in the catches. Males measuring 75 mm. and above were found to be mature while females of much higher size were immature, although a few were impregnated during November–January months. The percentages of impregnatecd females increased towards the close of the season. It is inferred that in March this species also leaves the inshore waters to attain sexual maturity in the deeper waters.

In the open Gulf region at Mundhra there is a monsoon fishery of a lesser magnitude (2–4 metric tons) during July–September for *Penaeus indicus* with the dominant size at 101–110 mm.

At Bombay.—As observed in previous years *Palaemon tenuipes* is the dominant species in the inshore fishery of Bombay during the current year. At all the three centres of observation, *viz.*, Versova, Sassoon Docks and Arnala its fishery is very heavy in April and the subsequent 2 months comprising 62·4, 63·2 and 50·3% of the total landings respectively.

After a slight decline in its abundance in July it shot up again in August. In October to December the fishery of this species is very low, recovering again in January. *Acetes indicus* is a main component of the catches of Versova and Sassoon Docks from December to March, comprising more than one-fourth of the catches. *Metapenaeus affinis* is abundant from September to November, with the peak in October when it contributes to 69·6% of the total landings. In other months the species occur only in small numbers. Compared to previous years its fishery this year was far better. The September catch consists entirely of young prawns whereas in the rest of the year adult maturing prawns of 10–15 cm. forms the majority. *Parapenaeopsis hardwickii* occur throughout the year but more in abundance from November to March, varying between 4·1 and 9·8%. *P. sculptilis* and *P. stylifera* occur in small quantities throughout the year. *Hippolysmata ensirostris* constitute a considerable fishery from June to September especially at Sassoon Docks. *Solenocera indicus* forms 9·7% of the landings in April. After May on the approach of the monsoon it completely disappears from the fishery, as observed in previous years, to recover again from November.

The offshore prawn fishery of Bombay was very poor this year. The percentage contribution of prawns in the years 1956–1961 are 13·8, 13·0, 4·4, 6·8, 8·4 and 3·0 respectively which shows the lowest percentage during the year under report. The monthly landings and catch per hour of prawns also show very low figures this year. *M. affinis* is the most abundant species from the middle of September to end of May. *P. stylifera*, *M. monoceros* and *M. brevicornis* in that order comes next in abundance. *Solenocera indicus* and *P. indicus* occur in small numbers occasionally. From the study of the length frequency and chemical contents of *M. affinis* three modes could be distinguished for the species.

At Ernakulam.—Observations on the fishery and biology of *Macrobrachium rosenbergii* were continued at two centres. The trend of the fishery is the same as last year, catches increasing from June onwards, reaching the maximum in August–September months and gradually declining afterwards.

Length-frequency data also follow the same pattern as last year, males belonging to 2-year classes and females of one-year class being represented in the catches. At both centres males dominate in the beginning of the season and as the season advances females become dominant. Berried specimens began to appear at Kumarakon earlier than at Ramankari. From the study of the occurrence of larvae in the plankton the breeding season as observed last year seems to be from September to December. Attempts to ascertain the distribution of the juveniles were continued this year also,

Juveniles also showed the same pattern of distribution, bimodal in males and unimodal in females.

As regards paddy field fishery, after harvesting the paddy crop in the experimental prawn farm at Thantoni Island towards the end of October, which yielded 376 paras of paddy, the field is being utilised for trapping and rearing prawns throughout the season with a view to find out whether that method is more productive than the usual trapping and fishing method employed in the locality. *M. dobsoni* is found to be the major species as noted earlier.

After the close of the fishing operations during the monsoon offshore fishery operations commenced early in October this year and fairly good catches of prawns consisting mainly of *P. stylifera* were landed in that month. In November *M. monoceros* which contributed to the major portion of the catches of that month in previous years was conspicuous by its absence in large numbers. As usual from December onwards *M. dobsoni* becomes the predominant species, showing two modes each for males and females, falling between 71 and 95 mm. and 101 and 120 mm. which may probably be the 1st and 2nd year groups. *M. affinis* is the species second in abundance. In January *P. indicus* of large sizes were present in large numbers.

This year the mud bank at Alleppey shifted slightly to the south and was located at Punnapara and the catches from this place show the same trend of species and size composition as in previous years. *M. dobsoni* is the dominant species and in July this is more or less the only species represented. The prominent length group shifted from 81–85 mm. in June to 91–95 mm. in August in males and 81–85 mm. to 106–110 mm. in females.

The prawn fishery of Kanyakumari District was comparatively poor this year. The fishery started late in July only. There were fairly good catches of *P. indicus* in August and first week of September after which the fishery came to a close.

During a research cruise on the vessel R. V. Varuna presence of large-sized *P. indicus* was observed while trawling off Ponnani in 48–54 metres depth. This might indicate the presence in this area in commercially exploitable concentrations of this large-sized prawns.

Work in connection with marking prawns making use of staining technique has been started. The different species of prawns are stained with trypan blue and kept in ground tanks at the departmental prawn field to note their mortality due to the staining effects.

Post-larval studies.—Studies on recruitment of penaeid post-larvae into the backwaters, which was discontinued for some time, has been started again from December onwards. Analysis of the data collected on the occurrence of these-post larvae in the plankton till 1960 shows the recruitment of these post-larvae of a particular year is reflected in the commercial fishery of the following year, thereby indicating the possibility of making use of this factor for predicting the fishery.

Lobster Fishery

The lobster fishery of Kanyakumari District after coming to a close in April revived in November. The estimated total landings for this and previous years are given below:

Months	Colachel				Muttom			
	1961–62	1960–61	1959–60	1958–59	1961–62	1960–61	1959–60	1958–59
November ..	5,186	..	..	..	17,078	..	..	..
December ..	8,188	7,525	6,954	19,958	39,800	18,160	17,718	53,645
January ..	5,535	4,489	5,536	19,292	28,877	13,746	9,842	36,661
February ..	2,486	..	..	9,306	3,428	..	5,586	9,200
March ..	874	1,064	745	3,325	214	2,298	1,138	2,200

The landings this season are much better than those of the two previous years, although not reaching the peak figures of 1958–59. The prominent size goups of the lobsters caught at Muttom are slightly higher than those at Colachel. At both centres the percentage of males remain higher than females in most of the months. A gradual decrease in the percentage of berried females is noticed as the season advances.

4. *Mullets*

At Kandla: Mugil parsia.—During the year mullet landings were rather poor except during January to March 1962 when good catches were landed at Kandla centre. From Mundra centre good catches were reported after monsoon, *i.e.*, October to December 1961.

Food.—Stomachs were invariably in various stages of fullness during October to January this year whereas in February to March they were either empty or had very little content in them. Food mostly consisted of dead organic matter with a good quantity of sand particles with it. The diatoms usually seen in stomach content are *Pleurosigma, Navicula, Coscinodiscus, Nitzschia, Diplonies* and algal filaments. Rarely crustacean remains and foraminiferan are also seen during monsoon times.

In size groups 180–199 mm. and 230–250 mm. gonads during monsoon were in very late stage of maturity and some spent individuals were also encountered during this time. During October 1961 juveniles measuring 3·9 to 5·6 mm. were also seen in market along with prawn catch. Then again in January to March almost all the samples obtained ranged from 180–270 mm. and gonads were in either IVE to VL stages of development. It appears that there is a prolonged breeding period.

At Mandapam.—The general observations made on the two common species of mullets, *viz., Mugil cephalus* and *Liza macrolepis*, on length-frequency growth, feeding and breeding have already been reported. Further studies provided interesting evidence on the peculiar habit of mullets in general with the identification of the "certain filamentous metter" reported earlier to occur in the stomachs of the above two species of mullets. The relative condition factors for *M. cephalus* for the different months during December 1958 to March 1960 have been worked out. The data collected on the food of both the species have been statistically analysed. Osteological studies revealed the basis for a clear understanding of certain genera of the Indian mullets.

5. *Tunnies*

At Veraval.—A good many gonads and guts were collected from specimens of *Euthynnus affinis* ranging in size 46·8–58·0 cm. Most of the ovaries were in Stages III and IV during the third and the fourth quarters.

For similar studies, available material was also collected from specimens of *Auxis thazard* and *Kishinoella tonggol.*

At Tuticorin.—The fishery for little tunny *Euthynnus affinis affinis* commenced in July 1961 and continued up to October 1961. They were landed at Tuticorin by whiffing lines and Nylon (Drift) nets. The landings were poor compared to 1960, due to inconsistent weather conditions. The size of the specimens ranged from 350–650 mm. in total length. The preliminary examination of the gut contents revealed that they feed on squids, sardines,

Anchoviella sp., carangids, etc. Mature and recently spent goands were encountered in the specimens during July–September mainly. During the rest of the period the landings consisted mainly of immature, early maturing spent-resting and spent recovering stages only.

At Mandapam.—Investigations on the fishery and biology of the oceanic, skipjack *Katsuwonus pelamis* and the yellowfin tuna *Neothunnus macropterus* collected at Central Marine Fisheries Research Centre, Minicoy Island, were continued. Samples from the tuna live-bait catches were also obtained regularly.

Studies on the size composition of the oceanic skipjack *Katsuwonus pelamis* and the yellowfin tuna *Neothunnus macropterus* from the Minicoy during the season 1960–61 have been completed. The composition of the landings and the catch-per-man-hour-effort for the various months of the season have been worked out. The total catches of all fish in Minicoy during the period November 1960 to April 1961 have been calculated to be over 1,100 tons. This consisted of *K. pelamis, N. macropterus, Auxis thazard, Euthynnus affinis, Acanthocybium solandri, Elagatis bipinnulatus, Caranx* sp., *Coryphaena hippurus* and sharks.

The relative abundance of the major tuna live-bait fishes of Minicoy was studied by the analysis of samples obtained from the bait fish catches. More than forty species of fishes occurring in the lagoon are used by the fishermen of Minicoy as tuna live-bait. Of these eleven species showed regularity in their occurrence. The size composition of three major species, namely, *Lepidozygus tapeinosoma, Archamia lineolatus* and *Caesio caerulaureus,* was studied. The majority of the bait fishes used are juveniles. *L. tapeinosoma* has been found to be the most suited among all the small fishes available in the lagoon to be used as tuna live-bait, though *Caesio tile* has been considered by the fishermen of Minicoy to be most effective in chumming tuna.

Food of *Katsuwonus pelamis* and *Neothunnus macropterus* from Minicoy waters during the season 1960–61 consisted of fish belonging to the families Dussumieridae, Gempylidae, Balistidae, Tetrodontidae, Dactylopteridae, Carangidae, Exocoetidae, Ostraciontidae, Apogonidae, Pomacentridae and Syngnathidae, and crustaceans represented by stomatopod larvae, megalopa and mysids formed the major items of food of *K. pelamis.* The proportions of these food items differed in small and large fishes.

6. *Pomfrets*

At Veraval.—Studies on the biology of the brown pomfret, *Parastromateus niger*, were initiated in September 1961 and data were collected systematically during the period September 1961 to March 1962. Examination of stomach contents revealed that the species feeds mostly on Salpids and Doliolids. Amphipods and stomatopods were also met with as food items.

The maturity stages of the species conform to the maturity scale adopted by the International Council for the Exploration of the Sea. The gonads were in Stages I, II, III and IV during the period September 1961 to January 1962 but in February and March 1962, they were in Stages I–III.

Random samples drawn during different months from the commercial catches showed that in September 1961, fish ranged in length from 22·0–48·0 cm. with two modes at 28–30 cm. and 38–40 cm. In October length ranged from 18·00–48·00 cm. with the 26–28 cm. group dominating. In November the 23·0–41·0 cm. were measured, size group 30–32 cm. dominated with a range of 23·0–41·0 cm.; during last week, small quantities of juveniles ranging in length 10–14 cm. also were landed. In December specimens ranged between 4·0–47·0 cm. and the 28–30 cm. group was dominant. During the period, January–March 1962, stray landings of *P. niger* ranging in length 26·0–41·0 cm. were recorded.

Pampus argenteus.—At Calcutta, analysis of the biological and landing data of Pomfret taken by the trawlers Kalyani II and Kalyani V of the West Bengal Deep Sea Fishing Board are being continued with a view to understand the changes in stock occurring in the various off-shore regions of the Bay of Bengal. The length-frequency distribution of 1,222 specimens were examined which indicate that nearly 80% of the Pomfret landings comprised fish below 220 mm. in length. Female specimens dominated the catch and nearly 75% of them were observed in the immature stage.

The investigations of the stomach contents of the young as well as the adult forms revealed that the former are plankton feeders depending mainly on copepods, whereas the latter feed on all the available organisms right from the surface to the bottom.

7. *Other Fishes*

Kurtus indicus.—The total quantity of 1,222·20 kg. of glass fish (*Kurtus ndicus*) landed this year was comparatively a very poor catch and this low

yield was because the vessels did not operate beyond sand heads. The length of fish landed varied from 90–150 mm. in the Calcutta zone.

Sciaena glaucus.—At Calcutta, this fishery formed 26·80% of the total landings of the year 1961–62. Out of the total catch of Sciaenids 52% was represented by *Sciaenia glaucus* which formed the major fishery of the coast. The fishes examined ranged between 12·2–21·2 cm. and the dominant size group varied from 12·2–15·8 cm. The peak period in the abundance of this species was observed in the month of January. The length at first maturity appears to be between 13·0–14·2 cm. Spawning and spent fishes were also recorded in good number during February to March indicating the breeding season. The males outnumbered the females. A scrutiny of the length-frequency data shows that of all the fishing grounds, the areas off Devi and Prachi River seem to be most suitable for the habitation of smaller groups of fishes.

The investigation of the stomach contents of *S. glaucus* revealed that it feeds mainly on *Squilla*, Crabs, Prawns, polychates, fish, molluscs, mud, etc., which indicates a bottom feeding habit.

At Waltair.—During the year under report studies on the biology of *Scomberomorus* spp. were completed and studies on the biology of *Leiognathus* and *Anchoviella* spp. were taken up.

Juveniles of *Scomberomorus* spp., namely *S. guttatus*, *S. commerson* and *S. lineolatus*, in the order of their abundance, were collected from Lawson's Bay. Specimens collected from Kakinada and the neighbouring fish landing centres were compared with these collected from Waltair area. Morphometric measurements, meristic counts, length-frequency studies, and analysis of stomach contents were completed.

8. *Molluscs*

At Tuticorin.—Studies on the seasonal gonadial variations of the adult pearl oysters were continued up to the end of July. The gonads of the oysters examined during the month of April were found with ripe eggs and sperms. However, a few oysters were also seen to be partially spent with a few developed oogonia still in the lumen. More or less the same condition of the gonad was seen in the oysters examined during the 1st and 2nd week of May. But the oysters examined from the middle of June onwards were found to be full with reproductive elements, almost ready to discharge their contents. Oyster spat were seen in the collections towards the end of July onwards.

The first phase of the underwater survey of the central sector which began in August 1961 was completed in January 1962, by means of echo-sounding and cursory aqualung divings. An area of 305 sq.km. was covered. Based on this, rocky areas encountered during the first phase of the survey work were taken up for detailed survey in the second phase. Dr. Salvadori, F.A.O. underwater expert, was at Tuticorin from December to the middle of February 1962. Up to the end of March a total of 342 dives had been made in lines I to XIII completing detailed observations on the rocky areas. Interesting fauna and flora collected during the work have been preserved and kept in the custody of the State Fisheries Scientific Staff.

9. *Offshore Fisheries*

At Veraval.—Three offshore fishing vessels M.L. 'Sagarpravasi' (Trawler), M.L. 'Sagarkanti' (Gill Netter) and M.L. 'Sagarvihari' (Gill Netter) operated during the period, the former during all the four quarters, the second vessel during the first quarter only (ended June 1961) and the third vessel during the third (ended December 1961) and the fourth quarters (ended March 1962—period January–February 1962 only having been considered). The three vessels among them landed 46,981 kg. of fish after expending an effort of 1250 hr. 50 min. The break-up of effort and catch of the three vessels is given below:

Vessel	Effort	Catch
M.L. Sagarpravasi ..	514 hr.-35 min.	41,088·0 kg.
M.L. Sagarkanti	204 hr.-45 min.	1,138·5 kg.
M.L. Sagarvihari ..	351 hr.-30 min.	4,754·5 kg.

M.L. Sagarpravasi operated both Larsen and Shrimp Trawls during the first and second quarters. During the third quarter, she operated the Larsen Trawl, Shrimp Trawl and the Trawl net. During the fourth quarter (January-February 1962 only), she operated the Russian Trawls, Shrimp Trawl and the Trawl net.

M.L. Sagarkanti operated surface and bottom-set gill nets during the first quarter.

M.L. Sagarvihari used both surface and bottom-set gill nets during the third quarter and only bottom-set gill nets during the fourth quarter (January-February 1962 only).

M. L. Sagarpravasi.—During the first quarter, this vessel operated only during May 1961, expended a total of 54 hours in the sub-areas SC. 6A and 6B of area 20–70, and landed 5,318·5 kg. of fish comprising 'Dhomia' 3,042 kg., Rays 1,095 kg., Wam 497 kg., Koth 178 kg. and Dara 143 kg. The overall catch rate for 'all fish' in the area 20–70 worked out to 98·5 kg./hr. The vessel fished in depths ranging between 20–37 metres.

During second quarter, the vessel operated only in September 1961, expended a total of 33 hrs. 15 min. in the sub-areas 5 B, 6 A and 6 B of area 20–70, within the depth ranges 26–40 metres and landed 3,324·5 kg. of fish with an overall catch rate for 'all fish'. at 99·9 kg./hr. The catch comprised Dhoma 865 kg., Rays 747 kg., Cat fish 687 kg., Ghol 581 kg., Wam 185 kg. and Prawns 125 kg.

During the third quarter, the vessel operated during all the months, expended a total of 317 hr.-15 min. in sub-areas 5 A, 5 B, 5 C, 6 A and 6 B of area 20/70 (within the depth-range 23–46 metres) and in sub-areas 1 F, 2 E and 3 D of area 21–69 (within the depth-range 32–40 metres) and landed 20,913 kg. of fish from both the areas—20–70 and 21–69. The break-up of effort and catch in the two areas is as under.

Area	Effort	Catch	Catch rate (All fish)
20–70	229 hr.-10 min.	13,728 kg.	59·9 kg./hr.
21–69	88 hr.-05 min.	7,185 kg.	81·6 kg.hr.

In the area 20–70, the catch comprised Dhoma 5,715 kg., Rays 1,735 kg., Ghol 1,401 kg., 'Others' 1,233 kg., Pervi 1,125 kg., Prawns 800 kg. and Catfish 578 kg.

In the area 21–69, the catch comprised Dhoma 3,440 kg., Catfish 1,095 kg., Ghol 571 kg., Rays 552 kg., Skates 365 kg., 'Others' 316 kg. and Wam 125 kg.

During the fourth quarter, the vessel expended a total effort of 110 hr.-05 min. in sub-areas 5 B, 5 C, 5 D, 6 A and 6 B of area 20–70 (within the depth-range 26–40 metres) and sub-areas 1 F, 4 C and 5 B of area 21–69 (within the depth-range 32–48 metres and landed a total of 11,532 kg. of

fish. The break-up of effort and catch (and also catch rate) in the two areas is as under:

Area	Effort	Catch	Catch rate (All fish)
20–70	55 hr.-55 min.	6,299 kg.	112·7 kg./hr.
21–69	54 hr.-10 min.	5,233 kg.	96·6 kg./hr.

In the area 20–70, the catch comprised Dhoma 2,320 kg., Rays 2,308 kg., Ghol 403 kg, 'Others' 381 kg, Sharks and Skates 279 kg., Pervi 210 kg., Kati 120 kg., and Catfish 109 kg.

In the area 21–69, the catch comprised Dhoma 2,280 kg., Rays 1,045 kg., Ghol 674 kg., Sharks and Skates 543 kg., Catfish 180 kg., Kati 150 kg., 'Others' 146 kg, and Wam 114 kg.

M.L. Sagarkanti.—The vessel operated gill nets in April–May 1961 in areas 20–70 and 21–70. Sub-areas 5 B, 5 C, 6 A, 6 B and 6 C of the former (within the depth range 17–40 metres) and sub-area 1 A of the latter (within the depth-range 20–28 metres) were fished.

In the area 20–70, a total effort of 144 hr.-45 min. were expended which yielded 808 kg. of fish, with a catch-rate 5·58 kg./hr. for 'all fish'. The catch comprised *Hilsa* spp. 177 kg., Sharks and Skates 167 kg., 'Others' 157 kg., Brown Pomfret 114 kg. and Silver pomfret 96 kg.

In the area 21–70, she expended 60 hours and landed 330·5 kg. of fish and the catch rate for 'all fish' worked out to 5·5 kg./hr. The catch comprised Brown Pomfret 92·5 kg., Sharks and Skates 85·0 kg., Palva 68·0 kg., 'Others' 55·0 kg. and Surmai 29·0 kg.

M.L. Sagarvihari.—The vessel operated gill nets in sub-areas 6 A and 6 B of area 20–70 (within the depth-range 26–40 metres) and in sub-areas 1 F, 2 D, 2E, 3 C, 4 C and 4 D of area 21–69 (within the depth-range 20–52 metres) in the third qaurter. In 20–70, an effort of 154 hr.–55 min. yielded 1,383 ·0 kg. of fish, with a catch rate for 'all fish' at 8·92 kg./hr. The catch comprised Sharks and Skates 407·5 kg., Palva 359·5kg., 'Others' 161·3 kg., Silver Pomfret 153·0 kg., Rays 113·5 kg., Brown Pomfret 75·5 kg. and Catfish 65·5 kg.

In 21–69, an effort of 132 hr.–25 min. yielded 1,440·5 kg. of fish and the catch rate for 'all fish' worked out to 10·87 kg./hr. The catch

comprised Silver Pomfret 529·5 kg., Sharks and Skates 401·0 kg., Palva 154·8 kg., Catfish 138·3 kg. and Brown Pomfret 80·3 kg.

In the fourth quarter, the vessel operated in sub-areas 5 A, 5 B, 5 C, 6 A and 6 B of area 20–70 (within the depth-range 29–52 metres), sub-areas 4 C and 5 C of area 20–71 (within the depth-range 20–28 metres) and sub-areas 1 F, 3 C, 3 D and 3 E of area 21–69 (within depth range 20–46 metres).

In the area 20–70, she expended 181 hr.–20 min. and landed 1,543·3 kg. of fish with a catch rate for 'all fish' at 8·51 kg./hr. The catch comprised Sharks and Skates 652 kg., Silver Pomfret 295·5 kg., Palva 266·0 kg., Ghol 128·0 kg. and Catfish 94·5 kg.

In the area 20–71, very poor results were obtained—a total effort of 27 hr.–35 min. yielded 11·0. kg. of Palva and Sharks and Skates with a catch rate at 0·39 kg./hr. In the area 21–69, an effort of 35 hr.–15 min. yielded 376·5 kg. of fish, with a catch rate for 'all fish' at 10·68 kg./hr. The catch comprised Sharks and Skates 233·0 kg., Palva 57·0 kg. and Silver Pomfret 48·5 kg.

At Bombay.—During the period under report offshore fisheries data collected by the various mechanised fishing vessels working from Bombay was analysed and the relative productivity of the various areas in respect of different species was studied. Besides keeping the routine analysis of data up-to-date, the unprocessed data of the year 1959 was completely analysed during the period. Regular monthly data sheets are now being prepared and sent to the headquarters in respect of the operations of all the fishing vessels working from Bombay with a view to disseminate these information to the various State Departments.

During the calendar year 1961 seven offshore fishing vessels were regularly working from Bombay. Of these four bull-trawlers of the New India Fishing Co., Ltd., Bombay ('Satpati,' 'Pilotan,' 'Arnalla' and 'Paj') concentrated their operations mainly off the Saurashtra and Cutch coasts while the three vessels of the Government of India Deep Sea Fishing Station, Bombay (M.F.V. Jheenga, M.F.V. Bumili and M.L. Meera) conducted fishing operations chiefly in the vicinity of Bombay. Two other vessels of the Government of India (M.L. Sagarvihari and M.L. Sagarpravasi) also conducted some fishing operations in certain months.

The introduction of Russian Method of Otter-Trawling with oval-shaped otter boards in the Government of India Fishing vessels is a significant development that has taken place during this year. During the

calendar year 1961 'Jheenga' and 'Bumili' worked continuously without interruptions while 'Meera', 'Sagarpravasi' and 'Sagarvihari' supported the operations in some of the months. These five vessels together landed a total catch of 3,59,650 kg. of fish comprising mostly of 'Dhoma', cat-fish, rays, sharks and others. The analysis of data has revealed that 'Dhomas' and elasmobranchs, which are not considered to be class fishes, formed bulk of the catches landed by these vessels.

The two pairs of the Bull-trawlers of the New India Fisheries Co., Ltd., Bombay, continued their fishing activities throughout the year and landed a total catch of 39,38,547 kg. of fish. The operations of these vessels were mainly concentrated in areas off Saurashtra and Cutch coasts (N, Q, R, S, U, V, etc.) in depths varying from 15–45 m. Although, as a single item, Dhoma (18·6%) formed major portion of the catch, the presence of other class fishes like 'Karkara' (11·4%), 'Wam' (7·6%), 'Ghol' (5·4%), Pomfret (1·1%), etc., in fair quantities made the catch more acceptable to the market. These vessels worked only occasionally in the Gulf of Cambay and in Veraval regions.

In the catches of the offshore fishing vessels 'Dara' was very poorly represented this year also. The percentage of dara has shown slight increase in the catches of the Government of India vessels whereas it has shown decrease in the catches of the New India Fisheries trawlers. The Daras landed by the Government of India vessels came mostly from the Cambay regions and their average size was about 90 cm. The New India Fisheries Trawlers caught Daras mainly from areas *L* and *N*, but these areas are not consistently fished and as such these figures do not show the real abundance of Dara population in the region. The size of Daras from these regions ranged from 38–78 cm. and they were all immature. The Gill-net fishery of Jamnagar brought fair quantities of Daras (85–103 cm., maturing) in the months of March and April 1961.

	Weight of Dara in kg.	% in the total catch	% last year (1960)
Government of India vessels ..	6,580	1·83	0·206
New India Fisheries vessels ..	63,840	1·62	2·03

'Ghol' landings in the catches of the Bull-trawlers were not as good as it was in the previous year (1960). Bull-trawler landings are as follows:

	Weight of Ghol in kg.	% in total
1960	2,82,965	6·66
1961	2,13,144	5·41

The peak landings of 'Ghol' were in the months of January to April and thereafter the landings declined to the minimum in October. In November the landings improved and shot up in December. This seasonal fluctuation which was noticed in the previous years also, probably indicates the movement of the species in the region. The Government of India vessels landed 12,361 kg. of 'Ghol' forming 3·43% of their total landings.

The trend of occurrence of 'Ghol' in the 'Dhol' net catches was similar to that observed in the previous year. By following the progression of the dominant size groups of the juveniles it is seen that the young ones developed from the eggs spawned in June–July grew to a size of 20–25 cm. by December —roughly at a rate of 5 cm. per month. The progression of 15–50 cm. size group from August to January 1962 in the trawl catches also suggested the same.

Stomach analysis showed that prawns formed dominant item of food of the juveniles although fishes were also taken occasionally. Feeding intensity of juveniles was found to be high during September to December when the inshore prawn landings were the maximum.

The cycle of events of spawning and maturation was similar to that observed in the previous years. The spawning season in the species is protracted extending from June to September. During April–June specimens in Stages IV, V, VI and a few VII were observed. From July to October spent and partly spent specimens appeared while those examined in October to March were in spent recovering stages of I and II.

A review of the 'Koth' fishery for the past 5 years clearly shows that there is a decline in the fishery. The decrease in the catches of 'Koth' from 1957–1961 is evident from the catch figures of the bull-trawlers given below:

	Weight of Koth in kg.	% in total catch
1957	86,998	2·71
1958	62,929	1·74
1959	56,198	2·06
1960	31,845	0·75
1961	23,778	0·60

It is possible that this reduction in the catches is brought out by the lesser exploitation of the 'Koth' abundant areas K, L, M and N off Dwarka in the recent years. The overall yield of 5·15 kg. of 'Koth' per hour is one of the poorest catch index figures for the species. However, when fishing was carried out in Koth abundant areas better yield of the species was realised. An yield of 131·28 kg./hr. was realised from area N in December 1961. One haul each tried in areas K, L and N in June 1961 brought out an yield of 61·11 kg./hr., 71·29 kg./hr. and 31·18 kg./hr. of 'Koth' respectively in those areas. A redeeming feature of the fishery to note was that more adults appeared in the catches than in the previous 2–3 years. This is probably due to the fact that more virgin areas like Q and R are being exploited.

Among the catches of the vessels of the Government of India it is seen that a total catch of 3,081 kg. of Koth was landed in the year 1961, of which 2,380 kg. were landed in February alone.

Most of the catches of Koth examined consisted of juveniles; I, II and III year catches dominated the catches of the Bull-trawlers. Length-frequency distribution of Koth from the catches of the year 1961 show three prominent modes at 24·5 cm., 52·5/59·5 cm. and 87·5 cm. These are in agreement with the modal position of the previous 3–4 years.

The Bull-trawlers of the New India Fisheries Ltd. landed 4,79,562 kg. of Karkara forming 11·4% of their total catches. In the catches of the Government vessels Karkara accounted for 2·9% of their total catch being 10,487 kg. in weight. Karkara fishery was very good from October to March. In the months of October and February the rate of yield of the species was of the order of 284·43 kg./hr. and 280·30 kg./hr. respectively. From June to

August the Karkara fishery was very poor and the catch rate touched a record low of 1·38 kg./hr. The highest ever catch rate of 625·2 kg./hr. was recorded from area V in depth ranges 34–43 metres in the month of October. The virgin areas being exploited in the recent years—off Cutch—appears to be very productive in respect of the species.

The length-frequency distribution of the species showed a bimodal distribution towards the end of the year and a unimodal distribution in the beginning of the year. Stomach analysis showed predominance of crustaceans in the total feed while fishes, bivalves and polychaetes were also encountered. The species was observed to be in the advanced stage of maturity from April to June and in September. In November-December the ovaries were in spent recovering condition.

The overall yield of 'Wam' did not show significant variations in the catches. The majority of the eels came from the Veraval region and their size range varied from 120–178 cm. Specimens above 125 cm. were mature in April and May.

	Weight of Wam in kg.	% in total catch	% last year (1960)
Government of India vessels ..	6,864	1·9	1·56
New India Fisheries vessels ..	2,98,854	7·58	7·01

It is found that Indian Mackerel (*Rastrelliger canagurta*) occur in small numbers in the trawl catches taken from Bombay and Saurashtra coasts. Most of the catches were recorded in November-December. Examination of the gut contents showed the presence of foraminiferan shells and sand grains indicating probable bottom habitat.

At Kerala.—During the period under review 'Pratap' carried out fishing operations along the Kerala coast only for four months from April–July 1961. The fish landings were highest in April–May when the total catch amounted to 57,640 kg. the catch per hour being 168 kg. As in the previous years 'Podimeen' formed the major catch (69%), sharks and rays forming the next important category (28%). After May, the total catch and the catch rate declined steeply. The operations of 'Pratap' have shown that a considerable decline in the availability of demersal fish stocks takes place in the coastal belt off Cochin during the monsoon months.

In April–July, 'Pratap' carried out trawling in two areas, as seen from the table given below:

Area-wise analysis of the catches of 'Pratap' from April to July 1961

Area	Depth (in metres)	Effort in hr.	Total catch in kg.	Catch/hr. in kg.	Catch per hr. (in kg.)				
					Podimeen	Sharks and rays	Karkara	Drepane	Perches
8–76 and 9–76 Cochin-Quilon area	14–53	380·42	61,147	161	109	45	0·17	0·46	..
7–77 (Off Cape Comorin Wadge Bank)	20–31	117·75	9,808	83	23	33	..	..	27

A comparison of catch rates between the two areas showed that the yield obtained in Cochin-Quilon areas was much higher—almost double—than that in Wadge Bank, the respective figures being 161 kg./hr. and 83 kg./hr. The lower catch rate in Wadge Bank may be attributed to the nature of the ground which is formed of shingles. The composition of fish catches also differed in the two areas. Whereas in Cochin-Quilon area the highest catch per hour of trawling was for 'Podimeen' (109 kg.), followed by sharks and rays (45 kg.), in Wadge Bank the maximum catch return was for sharks and rays (33 kg.), followed by perches (27 kg.) and 'Podimeen' (23 kg.). As in the previous year, the catches of 'Karkara' (*Pomadasys*) and Moon fish (*Drepane*) continued to be poor.

'Durga', 'Samudra' and 'Tarpon' continued shrimp trawling in areas 9–75, 9–76 and 10–75 lying off Cochin at depths of 4 M–54 M. Particulars of their operations from April–February are shown in the accompanying table.

The prawn catches in the summer months of April-May 1961 (26,821 kg.) were considerably higher than in the corresponding period of the previous year (11,973 kg.) the respective catch rates being 54 kg./hr. and 24 kg./hr. The total landings of these vessels in the post-monsoon period from September 1961 to February 1962 amounted to 2,49,876 kg. yielding an average return of 202 kg./hr. as against 98,913 kg. yielding an average return of 256 kg./hr. in the corresponding period the previous year. In September

Details of landings by the smaller mechanised vessels of Offshore Fishing Station, Cochin, for April 1961 *to February* 1962

	Depth (in metres)	Fishing effort (in hr.)	Total landings (in kg.)	Catch/hr. (kg./hr.)	Catch per hr. (in kg.)			
					Podimeen	Prawns	Sharks and rays	Perches
1961								
April ..	13–27	281·83	79,335	282	166	70	45	..
May ..	13–29	211·25	58,371	276	194	33	49	..
June ..	4–12	78·25	3,724	48	30	15	3	..
September ..	15–49	21·08	6,311	299	27	24	..	248
October ..	13–55	142·00	23,582	166	109	26	21	10
November ..	13–40	202·75	48,698	240	171	46	22	0·12
December ..	9–33	304·92	62,840	206	121	72	12	1
1962								
January ..	7–31	290·08	59,908	206	119	73	15	..
February ..	11–40	278·92	48,537	174	106	53	14	..

1961 good quantities of *Nemipterus japonicus* were caught in deeper waters beyond 36 metres. In the subsequent months of October 1961 to February 1962 fishing was concentrated more in the shallower waters, the catch comprising mainly of 'Podimeen' and prawns. The prawn landings which were poor in the earlier months of September–October, improved considerably in November–February, reaching the maximum in December–January when the catch rate rose to more than 70 kg./hr. The prawn fishery in September–February of this year was considerably better than in the corresponding months of the previous year, the average catch rates for these two periods being 58 kg./hr. and 22 kg./hr.

Indo-Norwegian Project Vessels based at Cochin.—The monthwise distributions of the catch and effort for the year under review are tabulated below, along with the likewise analysis of previous year, for comparison.

During the pre-monsoon period of the year (March–June) Indo-Norwegian Project Trawlers collectively made an effort of 728 hours in actual fishing. The areas visited were as usual *9–76*, 6 A, 6 B, 5 A and 5 B and *10–76* 1 A, areas immediately off Cochin. This resulted in a total landing of 126,247 kg. of fish and prawn, together working out to an average catch of 173 kg. per hr. of trawling. (During the same period of the previous year the average catch rate was only 143 kg.). The maximum catch rate, of 192 kg./hr. of trawling, was realised in May. In June, owing to the S.-W.

1961-62

Months*	March	April	May	June	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Total
Effort (hr.)	236	233	240	19	72	166	234	387	301	251	2135
Depth range (Metres)	7-33	15-27	11-29	..	36-55	18-36	5-29	9-18	8-35	13-33	5-55
Total catch (kg.)	37984	41311	46089	863	14569	14983	46017	85040	42526	40695	370077
Cateh per hr. of trawling (kg.)	161	178	192	45	202	90	166	222	141	162	173
Prawns (kg.)	9235	17594	12865	216	264	3307	12040	54686	25430	24135	159772
C/w of trawling prawns	39	76	54	11	4	20	51	143	85	96	75
Fish (kg.)	28749	23717	33224	647	14305	11676	33977	30354	17096	16560	210305
C/w of trawling of fish	122	102	138	34	198	70	145	79	56	66	98
					1960-61						
Effort (hr.)	451	438	252	127	27	102	125	158	152	165	1997
Total catch (kg.)	59889	54037	38804	28850	3407	34175	22377	12498	20724	28400	303161
C/hr. of trawling (kg.)	133	123	154	228	125	334	179	79	137	173	151
Prawns (kg.)	10584	17218	19553	25854	..	518	532	5687	6644	5425	90015
C/hr. of trawling prawns	24	39	78	202	..	5	4	36	44	33	45
Fish (kg.)	49305	36819	19251	2996	3407	33657	21845	6811	14080	22975	213416
C/hr. of trawling fish	109	84	76	26	125	329	175	33	93	140	106

* No fishing in July and August.

Monsoon, the fishing effort was very little, confined only to the first week of the month. The catch return was also poor (45 kg.) unlike the previous year when a catch per hour of trawling of 228 kg. was realised.

In the post-monsoon fishery of the year (September to June) the trawlers spent, in all, 1,407 hours in actual fishing in the same areas as in the pre-monsoon fishery, as against 729 hours in the previous year. This resulted in a total catch of 243,830 kg. of fish and prawn. The average catch rate worked out to 173 kg. (same as the pre-monsoon period). The highest catch rate of 222 kg. per hr. of trawling was realised in December. This figure

was very high compared with the same month of the previous year when only 79 kg. of fish and prawn were captured per hour of trawling.

In October this year, however, the catch rate showed a reverse trend, yielding only 90 kg. per hr. of trawling as against 334 kg. of the previous October. This was because the boats had shifted to the shallower regions comparatively early this year leaving the deeper *Nemipterus* grounds, which are generally highly productive due to the early appearance of prawn.

Catch composition.—A significant feature of this year's fishery was the relatively early appearance of prawns in the trawling grounds in the post-monsoon season; sizeable quantities of these were caught right from October onwards. The average catch rate for the year also was better than the previous year. (75 kg. per hr. of trawling as against 45 kg. of the previous year.) The total amount of prawn landed during the year was about 159,772 kg. comprising about 43% of the toal catches. Of this the maximum return was recorded during December when 54,686 kg. of prawn were captured at a rate of 143 kg. per hr. of trawling. During January and February also the catch rate remained more or less high, with 85 and 96 kg. respectively, per hour of effort.

The fish taken were an unsorted collection of small sized fishes like *Nemipterus japonicus, Otolithus argentius, Pseudosciaena sina, P. axillaris, Saurida tumbil, Platycephalus scaber,* Sole fishes, ribbon fishes, cat fishes, *Polydactylus,* white baits, etc. A total of over 210 tons of this mixture was landed during the year under review. The quanity landed this year, of *N. japonicus,* an important constituent of the catches from the deeper waters (30–45 m.) in the early post-monsoon fishery, did not compare favourably with that of the previous year, because the boats did not spend much time in fishing in these regions, owing to the early appearance of prawn in the shallower regions.

A preliminary study of the 'podimeen' from the different depths fished from October 1961 onward showed in general that the shallower region, up to a depth of about 13 metres, is characterised by the occurrence of greater percentage of *Otolithus argenteus, Opisthopterus tardoore, Caranx kalla* and *Trichiurus haumela,* while in the region between 14 and 27 metres the predominant species were *Otolithus argenteus, Pseudosciaena sina* and *P. axillaris,* in order of abundance. In the region deeper than 28 metres (up to about 48 metres) *Nemipterus japonicus* was the single major constituent although *Platycephalus scaber* also occurred in considerable quantities in

region ranging between 28 and 34 metres in depth. It was also noticed that the modal length of fish of many species caught from the deeper grounds tend to be greater than those from the shallower grounds.

Of the prawns landed from the various depths it was noticed that *Metapenaeus dobsoni* was the major species in depths up to 20 metres while in the deeper regions *M. affinis* and *Penaeus indicus* were common.

Study of the landings of mechanised boats at Azhikode Fishing Centre.—Seventeen Pablo boats are attached to this centre of which 8 are now operating off Malipuram, 7 off Azhikode and two off Kozhikode.

Out of a total catch of 76,426 kg. landed during January 1962, 79·85% consisted of prawns and 20·15% of miscellaneous small fish. The boats made a total of 171 day trips. In February 1962, 113 trips brought a total catch of 38,100 kg. catch consisting of 74·12% Prawns, 25·88% of fish. In March 1962, 150 trips brought a total of 38,532 kg. of catch consisting of 67·23% Prawns and 32·74% of fish. Prawn species taken in the catches were *Metapenaeus dobsoni, M. affinis, Parapeneopsis stylifera,* the first of which dominated in the catches. Of the fish constituents, sciaenids formed the major group including *Otolithus ruber, O. argenteus* and *Pseudosciaena sina.* The flat fishes recorded were mostly *Cynoglossus semifaciatus* though stray catches of *Synapterus zebra* were also recorded. Other species of fish taken were *Saurida tumbil, Caranx* spp., *Opisthopterus tardoore, Platycephalus scaber, Leiognathus* spp., *Anchoviella* sp., *Arius* spp., *Ambassis* spp., *Lactarius lactarius,* sharks and rays.

The table below gives an idea of the size composition of the different species of fish and prawns sampled from the landings at Azhikode.

At Tuticorin.—During the year under report four vessels M. Vs., Meenalochani, Sagarsundari, Sardinella and Meenakshi of the Offshore Fishing Station, Tuticorin, were operating. Shrimp trawls, bottom-set gill nets, R.C. Hooks, Long lines, Lobster nets and Drift nets were operated during the year. The gear-wise analysis of the data is presented below: The data of all the vessels using the same type of gear are pooled together, as the vessels are more or less of the same description.

Shrimp trawls.—Shrimp trawling was done mainly off Pinnakayal (Area 8–78/4 B) and Devil point (8–78/5 B). On a few occasions areas 8–78/2 A, 6 B and 8–77/2 F were also fished.

Species	January 1962		February 1962		March 1962	
	Size range (cm.)	Major size group	Size range (cm.)	Major size group	Size range (cm.)	Major size group
O. argenteus	15	..	10–16	13–14	9–15	14–15
E. sina	9–17	14	10–14	11	7–12	9–11
P. axillaris	9–10	10	..	..	9–11	..
Cynoglossus semifasciatus	12–26	12–14	12–15	14–15	11–17	13–14
Opisthopterus tardoore	14–15	14	4–17	9	8–16	9
Caranx kalla	9–14	9	10–13	10	10–14	11–13
Platycephalus scaber	17–22	17	..	..	9–22	..
Arius spp.	21–28	21–28	9–11	..	8– 9	8– 9
Saurida tumbil	21–28	..	17–21	..	12	..
Ambassis spp.	..	..	..	..	8– 9	..
Scoliodon	..	..	20–21	..	18–21	..
Leiognathus	4– 5	..	..	..	4– 8	4– 6
L. lactarius	..	..	..	..	13–14	13
		Prawns				
P. indicus	17–18	17	17	..	15–16	15
M. affinis	7–14	9–10	7–16	10–14	9–16	12–14
M. dobsoni	7–12	9–12	7–12	10	7–12	9–11
P. stylifera	8–11	8– 9	9–12	10–11	8–12	9–11

Area 8–78/4 B Depth range 12–38 metres Muddy Bottom

	Trawling hr.	Total catch (kg.)	Catch/hr. (kg.)
1961			
April	144·30	12,469	86·3
May	72·40	8,790	120·9
June	43·25	2,583	59·5
July	104·50	5,937	56·6
August	69·00	6,415	93·0
September	137·05	7,736	54·4
October	122·25	12,858	105·0
November	46·10	3,788	82·0
December	98·05	2,696	27·5
1962			
January	56·00	599	23·6
February	5·45	27	4·7

The percentage composition of the fishes caught

	April, May and June	July, August and September	October, November and December	January and February.
Prawns* ..	60·8	34·8	20·6	0·4
Rays ..	1·9	4·4	1·7	4·0
Skates ..	0·2	2·8	0·2	..
Trichiurus ..	6·3	4·9	8·5	..
Plotosus ..	1·9	1·4	0·4	..
Osteogeniosus ..	..	0·8	..	..
Sciaenids ..	11·7	22·7	24·2	5·
Leiognathids ..	7·7	4·5	21·6	60·3
Clupeids ..	3·2	4·5	2·1	1·7
Flatfish ..	1·8	2·5	2·4	1·8
Kurtus ..	..	3·2	1·0	..
Pomadasys ..	0·5	3·9	7·5	8·3
Therapon ..	1·2	3·5	1·1	..
Polynemus ..	0·5	1·6	1·6	0·4
Saurida ..	..	..	1·4	2·0
Upeneus ..	..	..	0·2	..
Drepane ..	..	..	..	3·0
Miscellaneous ..	2·3	4·9	5·6	12·2

* The prawn season extended from April to the first week of November. *Metapenaeus dobsoni, M. affinis, P. indicus, P. carinatus, Parapenaeopsis stylifera, Penaeus monodon* and *P. merguiensis* were the constituent species. Of these only the first three were important from the point of view of abundance. *M. dobsoni* and *P. indicus* were sporadically occurring in large numbers. *M. dobsoni* was especially abundant in April and May when they formed 70 and 59·8% respectively of the prawn catch and again in November (53·6%). They were least abundant in June (7%) and August (6·8%). *P. indicus* was particularly abundant in June (59%) and August (49·6%). They were least abundant in April (4%) and May (4·9%). This species occurred in large numbers when a strong westerly wind prevailed. Since this wind was intermittent *P. indicus* was also sporadically abundant. In contrast to these two species, *M. affinis* formed a steady proportion of the catches between May and November; its percentage fluctuating from 31·9 to 42·6%. Large mature specimens of *P. carinatus* (21·0–33·0 cm. in T.L.) were always present in small numbers specially in deeper section of the Pinnakayal trawling ground. Mature *P. merguiensis* (17·0–22·0 cm. in T.L.) were also present in small numbers but in shallow regions.

Area 8–78/5 B Depth range 4–5½ metres Muddy Bottom

	Trawling hr.	Total catch (kg.)	Catch/hr. (kg.)
1961			
April ..	2·00	4·5	2·25
July ..	4·00	117·8	29·4
August ..	1·30	21	14·0
September ..	6·40	164	24·6
October ..	11·25	426	37·3
November ..	23·15	934	40·2
December ..	33·20	1,300	39·0
1962			
January ..	54·50	1,019	18·6
February ..	35·50	727	20·3

In this area the composition of the catch did not change markedly with the seasons. Hence the average percentage composition for the year is given below:

Prawns ..	8·3	Clupeids ..	7·9
Crabs ..	2·5	Flatfish ..	7·9
Rays ..	3·7	*Kurtus* ..	2·4
Trichiurus ..	0·1	*Pomadasys* ..	0·1
Sciaenids ..	54·0	*Polynemus* ..	0·6
Leiognathids ..	0·1	Miscellaneous ..	12·3

In area 8–78/2 A shrimp trawling was done only in October. 8–45 hours of trawling yielded 577 kg. of fish averaging 66·0 kg. per hr. Prawns formed 12% of the catch and Sciaenids 64%.

In April one haul of 1–35 hours duration was made in the area 8–77/2 F yielding 19 kg. of fish. Leiognathids formed 71·5% of the catch.

In area 8–78/6 B, 693 kg. of fish were landed in 51–55 hours of trawling during February. The yield was 13·5 kg. per hr. Sciaenids formed 65% of the catch.

Bottom-set gill nets.—These were used mainly in areas 8–78/5 C and 5 B. A few sets were also made in areas 8–78/4 B, 4 C, 6 B and 6 C. Each set was made up of 8–12 nets.

Area 8–78/5 B **Depth 5½–22 metres** **Bottom: Rock with sand and mud.**

	No. of sets	Total catch (kg.)	Catch/set (kg.)
1961			
April ..	65	3,029	46·6
May ..	25	401	16·0
June ..	6	233	38·8
July ..	4	167	41·7
August ..	3	30	10·0
September ..	5	43·5	8·7
December ..	9	367	40·8
1962			
January ..	1	18	18·0
February ..	7	149	21·3

Percentage composition of the catches

	I Quarter	II Quarter	III Quarter	IV Quarter
Sharks ..	12·7	61·8	36·7	76·4
Rays ..	13·6	6·8	15·9	0·5
Skates ..	1·7	0·75	6·8	..
Chorinemus ..	5·0	..	..	..
Arius ..	53·2	6·6	4·6	3·0
Sciaenids ..	6·0	0·38	4·6	1·1
Chirocentrus ..	0·4	..	..	..
Seer fish ..	0·5	1·3	0·86	..
Pomfrets ..	0·5	..	14·6	..
Ilisha ..	0·4	..	11·5	..
Polynemus ..	0·5	2·3	..	..
Perches ..	0·5	1·3	0·37	1·4
Lobsters ..	1·4	4·3	..	..
Elacate ..	..	8·7	..	..
Miscellaneous ..	3·6	5·8	0·5	17·1

Area 8–78/5 C Depth 18–29 metres Bottom: Rock and sand

	No. of sets	Total catch (kg.)	Catch/set (kg.)
1961			
July ..	20	45	2·3
August ..	15	36	2·4
September ..	4	62	15·5
October ..	5	38	7·6
November ..	1	108	108·0
1962			
February ..	2	8	4·0

Percentage composition of the catch

Sharks ..	25·2	Pomfrets ..	1·4
Skates ..	10·1	Seer fish ..	4·3
Rays ..	33·8	*Caranx* ..	3·7
Sciaenids ..	2·8	*Elacate* ..	6·1
Arius ..	5·2	Perches ..	4·0
Ilisha ..	0·4	Crabs ..	0·3
Chirocentrus ..	0·3	Miscellaneous ..	1·4
Polynemus ..	1·1		

Area 8–78/4 B Depth 18–24 metres Bottom: Rock and sand

	No. of sets	Total catch (kg.)	Catch/set (kg.)
1961			
September ..	2	4·5	2·2
October ..	4	315	78·8
November ..	7	514	73·5
1962			
February ..	3	43·5	14·5

Percentage composition of the catch

Sharks ..	48·8	*Polynemus* ..	1·5
Rays ..	13·8	*Chorinemus* ..	5·7
Skates ..	6·2	Perches ..	3·1
Sciaenids ..	1·9	Crabs ..	1·0
Arius ..	3·0	Lobsters ..	3·6
Ilisha ..	6·8	Miscellaneous ..	5·7
Pomfrets ..	4·2		

Area 8–78/6 C Depth 18–22 metres Bottom: Sand

	No. of sets	Total catch (kg.)	Catch/set (kg.)
1961			
October ..	1	12	12
1962			
February ..	5	203	40·6

Sharks formed 54·6% of the catches, Elacate 15·8% and *Arius* 11·6%.

In October 2 sets in area 8–78/6 B yielded 150 kg. of fish. In November 2 sets in area 8–78/4 C yielded 180 kg. while in April one set of nets fished in area 8–77/2 F caught 175 kg. of fish.

Lobster nets

Area 8–78/5 B Depth 4–7 metres Bottom: Rocky

	No. of sets	Total catch (kg.)	Catch/set (kg.)
1961			
August ..	12	267	22·3
September ..	17	202	11·9

Percentage composition of catch

Lobsters	.. 37·3	*Arius*	.. 1·5
Sharks	.. 18·9	*Polynemus*	.. 1·5
Skates	.. 0·5	Perches	.. 7·4
Rays	.. 4·8	Crabs	.. 3·0
Sciaenids	.. 4·3	Miscellaneous	.. 20·8

Long lines.—Long lines were operated in area 8–78/5 B, 5 C, 4 B, 4 C and 6 C mainly between July and November. The results were poor and the data are summarised in the tables below:

Area No.	Depth range meters	Total catch kg.	No. of hooks operated	Catch/100 hooks kg.
8–78/5 B	11½–24	258	4900	5·3
8–78/5 C	14½–47½	326	7000	4·7
8–78/6 C	18 –20	16·2	800	2·0
8–78/4 B	16½–22	27·5	1600	1·7
8–78/4 C	18	37	400	9·2

Percentage composition of the catch

Area No.	Sharks	Rays	Skates	*Arius*	*Chori-nemus*	*Elacate*	*Caranx*	Seer	Perches	*Echineis*	Miscella neous
8–78/5 B	15·3	38·3	2·3	1·05	4·4	20·4	12·3	1·6	4·4	..	..
8–78/5 C	38·8	14·9	1·7	2·1	..	5·4	6·7	..	25·7	0·5	4·2
8–78/6 C	50·0	..	..	..	..	33·3	..	..	11·1	..	5·6
8–78/4 B	8·2	..	..	..	..	14·8	1·6	..	75·4	..	..
8–78/4 C	7·3	73·2	6·1	..	..	4·9	..	..	..	..	8·5

R.C. hooks.—These were operated between September and February in areas 8–78/5 B, 6 B, 6 C and 4 C. The results are summarised below:

Area No.	Depth range metres	Total catch kg.	No. of hooks fished	Catch per 100 hooks			Total average catch per 100 hooks (kg.)
				Stego-stoma	*Galeo-cerda*	*Carcha-rhinus*	
8–78/4C	27–42	2,139	910	6·3	214	..	220·0
8–78/5B	18–38	1,510	1,460	..	76·1	27·3	103·4
8–78/5C	22–36½	Nil	500	..	..	..	Nil
8–78/6B	24–25½	9	100	..	9	..	9
8–78/6C	24	Nil	100	..	..	..	Nil

Drift nets.—Drift netting was done on seven nights in areas 8–78/5C and 4 C. The total catch was only 67 kg. averaging 9·6 kg. per night.

At Waltair.—During the year under review 13 long voyages by the bigger vessels of the Government of India Offshore Station M.T. Ashok and M.T. Pratap lasting 76 days and 42 daily trips by the smaller vessels M.V. Sea Horse and M.V. Champa were undertaken by the scientific workers of the unit. The region between Visakhapatnam and False Point consisting of 45 squares were explored by the bigger vessels and 10 squares by the smaller ones. Intense fishing by Ashok and Pratap were restricted to Squares—17–83/C-5, B-5, D-5, D-5, E-6; 18–83/F-1; 18–84/A-1; B-2; C-3 and E-4. In other regions fishing for either two or four hours only was done. A total of 367·10 hours spent in fishing yielded a catch of 96369 kg. of fish, *i.e.*, 262·8 kg./hr. of fishing. The catch returns per hour of fishing in the various areas ranged from 1 kg./hr. recorded in Square 18–84/C-2 to 708 kg./hr. in 18–84/B-3. However, in heavily fished areas it ranged from 85·6 kg./hr. made in Square 18–84/C-2 to 610·3 kg./hr. in Square 31. The following squares, where fishing was intense, the yield was squares 18–83/F-1=309·6 kg./hr.; 18–84/A-1 = 296 kg./hr.; 19–86/A–4 = 247 kg./hr.; 18–84/C–3 = 218 kg./hr.; 17–83/D-6 = 173·00 kg./hr.; 17–83/ D-5 = 146·6 kg./hr.; 17–83/E-6 = 142·2 kg./hr. and 17–83/C-5 = 138·5 kg./hr.

The areas fished ranged in depths from 30–124 metres and were characterised by mostly muddy sand or mud or sand and mud bottoms.

Although about 37 species were recorded in the catches only a few were important contributors to the trawl fisheries and they were *Arius* sp., *Johnius* sp., *Pomodays hasta*, *Nemipterus japonicus*, *Caranx* sp., *Upeneus* sp. which respectively yielded 42·6, 31·6, 31·2, 23·2, 14·3 and 10·9 kg./hr. The yield of Sharks, Rays, Perches and *Saurida tumbil* ranged from 8·1–8·9 kg./hr. Fair quantities of *Pellona* sp. (7 kg./hr.); *Leiognathus* sp. (6·9 kg./hr.); Pomfrets (6·8 kg./hr.) and Skate and *Penaeus indicus* (each yielding 5·2 kg./hr.) were landed. Catches of other varieties ranged from 0·01 kg./hr. to 4·8 kg./hr.

Fishing by Champa and Sea Horse was mostly confined to two areas, *i.e.*, 17–83/C-5 and 17–83/B-4. Which gave 79·5 and 145·0 kg./hr. The highest yield was registered in 17–83/C-5/D-5 (349·5 kg./hr.). Altogether 226·00 hours of fishing produced a catch of 20,517 kg., *i.e.*, 90·6 kg./hr. of fishing. Squares 17–83/B-3, 17–83/C-3/D-4, 17–83/B-4, 17–83/C-4/B-3, 17–83/C-5/D-6, 17–83/D-5 yielded respectively 149·5, 110·2, 56·2, 95·0, 88·7 and 34·8 kg./hr. in 4, 5, 6, 3, 5, 50 and 4 hours. Most of the species recorded by Ashok and Pratap were common to Sea Horse and Champa. However, only five species were of any importance as contributors to the fishery and they were *Johnius* sp., *Arius* sp., *Nemipterus japonicus*, *Saurida tumbil*, Rays and *Upeneus sulphureus* which respectively recorded 17·6, 13·8, 11·4, 6·6, 6·5 and 5·3 kg./hr. Rest of the species ranged from 0·1–2·2 kg./hr. of fishing. The areas fished ranged in depths from 10–66 metres and were characterised mostly by mud.

At Calcutta.—A total number of 32 fishing voyages were performed by these vessels and they brought 5,08,031·04 kg. of fish during the period under review. Table 1 shows the catch by class as well as the number of voyages made by each of fishing vessels.

TABLE I (1961–62)

Name of the fishing vessel	Total No. of voyages	Catch by class in kg.			Total	Grand total kg.
		A	B	C		
Kalyani II	3	410·30	16,770·60	..	17,180·90	5,08,031·04
Kalyani III	12	15,240·71	1,59,312·15	12,719·64	1,87,272·50	
Kalyani IV	7	4,363·02	1,17,018·26	1,829·36	1,23,210·64	
Kalyani V	10	14,051·50	1,62,821·50	3,494·00	1,80,367·00	

The details of the catch composition of the different species of fishes landed by Kalyani III–Kalyani V during the year under review are given below; whereas the specieswise composition for Kalyani II was not available except for a consolidated account of A, B and C class categories of fishes (which has been included in the total landings).

	kg.
'A' Class fish :	
Pomfrets	22,581·33
Prawns	3,259·08
Pomadasys hasta	6,943·44
Pseudosciaena diacanthus	19·00
Polynemus indicus	10·00
Lethrinus spp.	534·73
Lutjanus spp.	259·80
Otolithus spp.	47·85
	33,655·23
'B' Class fish :	
Sciaenids	2,61,878·26
Pellona spp.	45,544·69
Nemipterus spp.	26,268·75
Arius spp.	17,150·63
Upeneus spp.	13,672·19
Lactarius lactarius	9,151·37
Caranx spp.	11,146·22
Muraenesox talabonoides	11,345·25
Chirocentrus dorab	2·48
Acetes spp.	1,150·00
Leiognathus spp.	12,247·33
Kurtus indicus	1,222·20
Rastrelliger kanagurta	2,472·80
Lutjanus spp.	6,026·75
Cybium spp.	40·45
Small prawns	821·00
Polynemus spp.	575·00
Raconda russelliana	52·73
Miscellaneous	18,383·81
	4,39,151·91

	kg.
'C' Class fish :	
Rays	5,469·07
Bombay duck	1,661·00
Ribbon fish	110·00
Skates	2,635·17
Catfish	1,274·00
Pristis spp.	2,597·01
Sharks	1,954·13
Rhynchobatus djiddensis	134·12
Miscellaneous	2,208·50
(Damaged variety of 'B' Class) Total 'C' Class ..	18,043·00
Grand Total ..	4,90,850·14

In Table II is represented a comparative account of catch by class, total catch, etc., of the years 1960–61 and 1961–1962.

TABLE II

Period	Total No. of voyages	Catch by class in kg.			Total catch in kg.	Catch per voyage in kg.
		A	B	C		
1960–61	23	12,008·29	1,43,003·76	5,640·84	1,60,652·89	6,984·91
1961–62	32	34,065·53	4,55,922·51	18,043·00	5,08,031·04	15,875·97

The details of the monthwise and areawise catch and other relevant information are given in Table III.

The total quantity of marine fish landed during the years 1961–62 amounted to 5,08,031·04 kg.; out of the total catch 'A' class was represented by 34,065·53 kg., 'B' class by 4,55,922·51 kg. and 'C' class by 18,043·00 kg. The highest catch of 1,87,272·50 kg. of fishes was landed by Kalyani III and lowest total of 17,180·90 kg. of fishes was landed by Kalyani II. It is also to be noted that Kalyani III brought the maximum quantity of 15,240·71 kg. of quantity fishes belonging to 'A' class variety (Table I). They were mainly represented by Pomfret, Prawns and perches of which *Pampus argenteus* formed the main bulk constituting 67% of the total 'A' class catch.

TABLE III

Area of fishing	No. of voyages	No. of days	Depth in fathoms	Catch by class in kg.			Total catch in kg.	Total monthly catch in kg.
				A	B	C		
Eastern Channel ..	2	13	10–15	39·27	1,628·77	239·36	1,907·40	1,907·40 April, 1961
Western Channel ..	1	8	15–18	55·50	1,510·00	627·00	2,192·50	2,192·50 Sept., 1961
do. ..	1	9	18–20	..	1,406·00	1,850·00	3,256·00	2,256·00 Oct., 1961
Sand Heads ..	2	21	20–40	1,024·00	28,849·00	520·00	30,393·00	46,136·00 Nov., 1961
Off Puri Coast ..	1	12	8–10	131·00	15,158·00	454·00	15,743·00	
Sand Heads ..	4	41	12–30	7,603·00	70,981·55	3,296·00	81,880·55	88,109·65 Dec., 1961
Eastern Channel ..	1	13	12–20	261·10	5,968·00	..	6,229·10	
Sand Heads ..	5	52	10–30	7,824·91	1,06,664·18	2,760·18	1,17,249·23	1,45,509·89 Jan., 1962
Western Channel ..	1	11	15–20	3,079·55	22,793·91	..	25,873·46	
Eastern Channel ..	1	7	12–25	149·20	2,238·00	..	2,387·20	
Sand Heads ..	4	37	15–30	3,717·50	75,836·00	2,529·00	82,082·50	1,15,220·60 Feb., 1962
Eastern Channal ..	2	18	14–30	656·00	31,222·10	1,260·00	33.138·10	
Sand Heads ..	7	71	12–25	9,524·50	91,667·00	4,507·50	1,05,699·00	1,05,699·00 March, 1962
Grand Total ..	32	313	8–30	34,065·53	4,55,922·51	18,043·00	5,08,031·04	5,08,031·04

The comparative analysis of the catch during this year with that of previous year (*vide* Table II) reveals that there is a remarkable increase (over 3 times) in the total catch as well as the average catch during this year. It is also remarkable to note that there is a considerable increase in the catch of the quality fishes belonging to the 'A' class category.

The fishing activities of the trawlers, Kalyani II to Kalyani V started by the middle of September 1961 since May–August was the monsoon period. The fishing was confined for the areas off Western channel, off Eastern channel, Sand Heads and off Puri coast at a depth ranging from 8–40 fathoms. Of the fishing regions sand heads was fished more during this year. A detailed scrutiny of the data revealed that off Western, Eastern channel and Sand Heads were dominated by species of *Sciaena*, Clupeids and *Arius*, etc., of which *Sciaena* spp. formed the main bulk and off Puri coast was noted for perches and *Leiognathus* spp.

Sciaenids formed the major fishery of this coast comprising 51·55% of the total catch of which *Sciaena glaucus* formed the main bulk constituting 26·8%. A peak period of the abundance of Sciaenid fishery was observed in the month of January 1962. The dominant species, *Sciaena glaucus*, ranged from 12·1–21·2 cm. The maximum size groups with the mature specimens were recorded during the months of January and February. A sigrificant increase in the landings of clupeids and silver bellies was observed. A gradual decrease in the glass fish fishery (*Kurtus indicus*) was noted and was represented by 6·2% as against 9·3% of the previous year. A remarkable feature of the occurrence of the Indian mackerel (*Rastrelliger kanagurta*) in the deeper regions of the Bay of Bengal 21–40 fm. was observed. Pomfrets and prawns formed a negligible quantity of the catch constituting 4·5% and 6% respectively.

A progressive increase in the production of the marine fish catch was noted (*vide* Table III) with the approach of winter season January, February and March were the productive periods. A peak period in the landings was noted in the month of January, during which period a total catch of 1,45,509·89 kg. was obtained which formed 40·8% of the total fish landings of the year. It is also obvious from the table that a total of 4,17,304·28 kg. was caught from Sand Heads as against the total catch of 5,08,031·04 kg. 26,347·91 kg. were represented by quality fishes belonging to 'A' class category which indicate the quality fishing ground, between 12–20 fm. depth at Sand Heads the catch was more abundant during this year.

10. *Marine Fish Farm and Physiology*

Marine fish culture.—At Mandapam the results of fish culture experiments in the marine fish ponds during 1961–62 were consistent with those obtained during previous years. Thus, based on three years' experience certain general conclusions have been drawn and they are summarised below: (1) If milkfish is reared in these ponds year after year the yield definitely tends to go down every time. (2) The maximum limit of average annual yield possible in these waters is 400 pounds of fish per acre and the average individual growth of the fish during this period is 350 mm. (3) The optimum stocking rate seems to be 2,500 fingerlings per acre and any further increase in stocking rate does not produce increase in yield. (4) Mullets can also be reared in these ponds with more or less the same results, but the availability of fingerlings in sufficient numbers for stocking might be a major problem.

It may be pointed out here that the present annual yield does not seem to be quite economical from a commercial angle. Some of the inherent physical and chemical factors are responsible for limiting the fish production. Therefore, investigations during this period have received special emphasis on such of those chemical factors that have a direct bearing on the biological production in these waters.

Analysis of the data reveals that the salinity and oxygen content of the waters depend entirely on the exchange with the open sea and on local rains. During the summer season the salinity of the ponds in general was 46·18‰ and in one case it touched even 51·00‰. Only during the North-East monsoon period the salinity was low and comparable to the adjacent sea. The dissolved oxygen concentration varied between 2 c.c./l. to 4 c.c./l. The maximum values were noticed during December.

Nitrate concentration of the ponds was in general very low. During certain periods complete depletion was noticed as in December. In ponds Nos. IV and VI a sudden rise in the concentration was noticed during the months of May and September respectively and this lasted for a period of 3–4 weeks. There was not set pattern of changes in the inorganic and total phosphorus constituents which occurred in low concentrations. In December complete depletion was observed in all ponds. The total phosphorus concentration varied between 0·760–2·49 μg. at./l. The highest values were observed during the month of October.

A parallel analysis of the mud samples from ponds Nos. I, II and III was carried out, with a view to study the exchange of nutrients, especially

phosphate, between the mud and water phases. The interstitial, adsorbed and total phosphorus varied between 0·542 μg./g. of mud to 1·61 μg./g. of mud. The maximum and minimum values of adsorbed phosphorus observed were 24·2 and 5·85 μg./g. of silt. The total phosphorus content was found to be generally high and varied between 131·6 μg./g. of silt to 436 μg./g. of silt. An inverse relationship between the total phosphorus of the mud and that of the overlying water was observed. It was suspected that the low concentrations of the nutrient salts might be due to the complete utilization by the plankton community, which was disproved by primary production experiments conducted in ponds I and II. Ponds I and II were fertilised with compost manure in the first week of August; since no effect could be noticed the fertilisation was not carried further.

Physiology. At Mandapam.—The work on fish-fry and fingerling transport was continued by the use of a classical method of determining rate of metabolism. This was worked out in the fingerlings of the mullet, *Liza tade*, in the different conditions of salinity, in order to find out the suitable medium for its transport. Experiments were carried out in the freshwater and also in the salinities of 34·0‰ and 22·0‰. In each experiment about 20 individuals were employed. Work on the study of the metabolism in the groups of fingerlings of the mullet *Liza tade* is in progress. With the occurrence of the *Chanos* fry in the inshore waters, work on the possibility of their transport in polythene bags is begun.

Marine fish-farm at Mandapam was found to be inhabited by the edible clam *Meretrix meretrix* (Linn.) in great abundance. The density of population ranged from about 25–75 clams per square metre. It was also observed that the ponds where these clam grow, the general growth of the culture fishes was not appreciable. In view of this, it was decided, firstly, to find means to eradicate these molluscs for the benefit of fish culture; and secondly, to explore possibilities of carrying out clam culture besides the usual fish culture in the Marine fish-farms.

Experiments carried out indicated that these clams have a great physiological adaptation to the salinity range, and hence lowering of the rate of filtration by increasing or lowering the salinity is not practicable in eradication of clams for the benefit of the fish culture.

In view of the above observations, it was decided to use inorganic molluscicides to eradicate molluscs without affecting the culture fishes. Experiments are presently in progress to find the effect of copper compounds on these molluscs and also on culture fishes.

For the clam culture, data was collected on the breeding of these clams in the fish-farm. Preliminary analyses of the data indicate that though sexes could be distinguished more or less through the period, they are more marked during late October to March or April. Peak spawning appears in November and spawned individuals occur till March. There is no marked change in the percentage edibility of these clams during any time in the year.

IV. Marine Biology

1. *Planktology*

At Karwar.—In general the production of plankton as indicated by the displacement volume was poor. During the 3rd quarter of the year it was comparatively high.

Phytoplankton hardly appeared to bloom. However, it exhibited a bimodal curve, with the major peak during May–August and the minor peak in January-February. *Chaetoceros* spp. and *Coscinodiscus jonesianus* were the important forms all the year round. Other important forms were *Thallassiothrix frauenfeldii, Nitzschia seriata,* and *Rhizosolenia* sp. Besides these many other forms were present in the plankton in smaller numbers. *Trichodesmium* and Dinoflagellates were poor at all centres compared to the previous year.

Tintinnids and *Noctiluca miliaris* were poor at all centres when compared to that of the previous years. Larvae of copepods, decapods, polychaetes and molluscs and many other planktonic larvae were present in smaller numbers and they occurred mostly in the latter part of the year. Occurrence of cladocerans was poorer this year. Copepods formed the major item in almost all the samples of plankton. *Acrocalanus longicornis* and *Acartia erythraea* were the most important forms in the order of abundance although, *Acartia* occasionally dominated *Acrocalanus* in the southern stations. In the previous years *Acartia* dominated in the south and *Acrocalanus* in the north. *Schmackeria serricaudata, Oithona oculata, Temora turbinata* and *Euterpina acutifrons,* which usually occur in plenty during the mackerel season, were sparsely represented in the plankton. These forms along with dinoflagellates and cladocerans form the major food elements of mackerel and the absence or scarcity of these in the inshore area at the time of mackerel season may explain the paucity of mackerel shoals along the coast and the consequent failure of the fishery for the year under report. Chaetognaths were rare before the monsoon and absent during the monsoon. In the post-monsoon months they appeared in comparatively good

numbers. Unlike the previous years *Sagitta bedotei* was dominating along the entire coast. Occasionally *S. enflata* appeared to dominate at all places. In the previous years *S. enflata* dominated in the north and *S. bedotei* in the south. *Lucifer hanseni* and appendicularians were found to occur in good numbers after the monsoon. Fish eggs and larvae were found in the plankton in small numbers all the year round.

At Mangalore.—Regular weekly plankton collections at the 4 fm. area Ullal were made throughout the year except during the South West monsoon when rough weather prevailed. The displacement volumes of the surface hauls were low till August, but showed increase from September to December. From January to March 1962 the volumes were again low. The rise in volume in September was due to the swarming of the cladoceran *Penilia avirostris*. The high volumes noticed during October to December were due to unusual phytoplankton blooms.

In April blooms of diatom *Bellarochia malleus* and *Pleurosigma* sp. were recorded. Other dominant species of diatoms were *Hemidiscus*, *Coscinodiscus* and *Chaetoceros*. In early May *Trichodesmium* sp. contributed to the bulk of the phytoplankton. Species of *Thalassiothrix*, *Chaetoceros*, *Pleurosigma* and *Ceratium* sp. were recorded in small numbers. In September, phytoplankton was comparatively poor. Towards the end of this month *Fragilaria oceanica* appeared in good numbers. There was an increase of phytoplankton from October onwards, the important species being *Thalassiothrix*, *Rhizosolenia*, *Biddulphia* and *Chaetoceros*. These species continued to occur in November also. A bloom of *Coscinodiscus* sp. was recorded in December.

The planktological conditions this year were radically different from those of previous years and it is interesting to note that the fishery conditions had also changed radically in this zone. The sardine fishery was exceptionally good in the Mangalore area (between Ullal and Suratkal) while the mackerel fishery was a total failure this year. Phytoplankton was comparatively rich in the inshore waters of Ullal and also in the nearby centres and this coincided with heavy landings of oil sardine in the area between Ullal and Suratkal. In January 1962 there was a decrease in the proportion of phytoplankton. *Bellarochia malleus*, *Coscinodiscus* and *Hemidiscus* were observed in moderate numbers. During the second half of February *Pleurosigma* sp. was found to be very common, when again heavy catches of oil sardine were recorded at Mangalore and nearby northern centres. In early March, phytoplankton was poor and towards the close of the month the bulk was increased by species of *Pleurosigma*, *Rhizosolenia* and *Chaeto-*

ceros, when again moderate landings of oil sardine were observed. The unprecedented phytoplankton blooms from October to December, the relative sparsity of zooplankters like copepods and larval invertebrates, during the regular mackerel fishery season, and the occurrence of such items as *Lucifer* sp., and their zoea in considerable numbers as early as in December and January while in the previous years they occurred in appreciable numbers only after March or April, are departures from normal trends. The copepods *Temora turbinata, Pseudodiaptomus danglishii, Centropages* spp., *Acrocalanus* spp., and *Paracalanus* spp., which usually occur in good numbers from October onwards, were poorly represented this year. Larval mollusca, penaeid and brachyuran zoeae, and fish eggs and larvae were also poor. In February 1962 Cirriped nauplii occurred in plenty.

At Cannanore.—The main deviation from the pattern of seasonal abundance of planktonic organisms was the delayed commencement of the monsoon bloom of diatoms. The characteristic outburst of phytoplankton, noticed every year with the commencement of the rains in June, did not take place until the middle of July and even then, the bloom was comparatively less intense and did not last longer. *Fragilaria* bloom was particularly of a short duration. The minor peaks were also comparatively of lesser intensity during the year under review.

The zooplankton fluctuations were more or less regular as in the previous years; but the total plankton production was very moderate as seen from the displacement volumes. The *Noctiluca* swarming did take place from July to September, there was no outburst of polychaete larvae in June and July, as was seen in the previous years. There was the usual peak period from August to November for clupeid, carangid and scombroid eggs.

At Kozhikode.—The seasonal cycle of phytoplankton showed many peculiarities this year, with a primary bloom of extremely low intensity in spite of heavy rains during the S.-W. monsoon season attaining the maximum by volume and pigment in July and the minimum in January-February. There was no secondary bloom. In general, the standing crop of phytoplankton as also the total plankton remained low throughout the year. The standing crop was poorest for the last five years. The blooms were more pronounced at the nearshore station. There was no sustained unispecific bloom of *Fragilaria oceanica* this year, or of any other species. Diatoms predominated during the S.-W. monsoon season and this dominance was slightly dislodged by Dinophyceae and blue-green algae during the N.-E. monsoon season. *Skeletonema costatum, Chaetoceros lorenzianus, C. compressus, Asterionella japonica, Lauderia annulata, Schroederella delicatula, Rhizo-*

solenia stolterfothii, *Nitzschia seriata*, *Thallassiothrix frauenfeldii*, *Thalassionema nitzschioides*, *Thalassiosira subtilis*, *T. hyalina* and *Biddulphia mobiliensis* were the predominant diatoms.

By the end of this year, two and half years' data on primary organic production by the 'Dark' and 'Clear' bottle experiments were collected for the original eight stations covering an area of about ten miles from the shore. This year the experiments were extended to the subsurface layers to get an idea of the gross production in a vertical column of water. The average annual rate of production was found to be of a lower magnitude this year which is mainly due to the absence of a marked primary monsoonic bloom; for other seasons the readings agree with the previous observations.

In April and again the post-monsoon months copepods were the most significant group of the zooplankton though they appeared less numerous than in previous year. The common species of *Acartia*, *Labidocera*, *Temora*, *Eucalanus*, *Centropages*, *Corycaeus*, *Oithona* were mainly available. The cladocerans *Evadne*, and *Penilia* too had a restricted abundance, the former being confined to about a month in September, while stray swarms of *Penilia* lingered on in early October. However they, especially *Evadne*, continued to be represented in the collection in extremely poor numbers all through the year. Chaetognaths were fairly numerous in the pre-monsoon period and again intermittently in the last quarter. Sergestid and penaeid eggs and larvae were obtained during the last quarter, though in less abundance than usual. Medusae and salps were common in November-December. Siphonophores were plenty in the September collection and again in much reduced numbers in the last quarter. Others of fair but restricted occurrence were pteropods and heteropods, appendicularians, ctenophores. *Noctiluca* swarms were noticed in September. Fish eggs and larvae were obtained from September onwards, mainly in September-December.

At Ernakulam.—The study of plankton collections from Cochin Harbour Waters was begun in December 1961 and is proceeding according to a regular schedule from January. The copepods in these collections have been uniformly rich, comprising some 20–30 species. Phytoplankton has been absent or neglibile. Inedible plankton constituents such as *Sagitta*, Ctenophora or Hydromedusae have been scanty.

At Mandapam.—Studies on the chaetognaths of the Palk Bay and Gulf of Mannar were completed, as well as analysis of the chaetognatha from the R.V. Kalava collections from the Laccadives.

Attempts to rear the planktonic fish eggs collected from plankton, in the laboratory, were not successful. Efforts to obtain ripe fish in order to try artificial fertilization were also not fruitful.

Investigations on primary production were continued in the Gulf of Mannar and Palk Bay. Apart from the oxygen technique which was used for routine work, C^{14} experiments were also conducted at selected inshore stations and a few offshore stations at Tuticorin and in the Laccadive sea. Some of these were concurrent experiments. Besides getting a general idea of the productivity of these regions, these experiments have also enabled to derive a suitable photosynthetic quotient to calculate the carbon uptake from oxygen experiments.

From the few sets of experiments that were conducted in the Laccadive waters, it was observed that the waters around Minicoy Island were more productive than that of Kalpeni and Androth Islands. In the deeper waters of Minicoy, where active tuna fishing was being conducted, the photosynthetic zone extended over 75 metres and the average rate of production amounted to *ca* 300 mgC./m^2/,day. Higher rate of production could be expected if the seasonal maxima of the S.-W. monsoon period, characteristic of the West coast, is also taken into consideration.

The values of primary production for the inshore waters of the Gulf of Mannar and Palk Bay ranged from 20 mgC./$m.^3$/day to 435 mgC./$m.^3$/day, Palk Bay having a higher rate.

At Tuticorin.—Wide fluctuations were noticed in the displacement volumes. The standing crop was observed to be low during November to January. When zooplankters occurred in large numbers (June to October) the displacement volume increased. A similar condition was observed in the previous year and volumes as high as 50 c.c., observed in the months June to September.

Blooms of *Trichodesmium erythraeum* were observed in the months of April 1961 and March 1962. Good numbers of them were occurring in the months February, May, August and October. Diatoms, especially species of *Coscinodiscus, Thalassiosira, Thalassiothrix, Guinardia, Rhizosolenia, Ditylum, Biddulphia* and *Chaetoceros* were common in the summer months. There was a bloom of *Rhizosolenia* in the second week of August, last week of October and in the first and second week of December. Blooms of *Guinardia flaccida* were noticed in the months October and December. Comparing this year's observations with the previous year's it appears that the diatoms start occurring with a small peak in the summer months and

dwindle down in the monsoon months when zooplankton dominate. Again when calm conditions return a second major peak occurs during September to December. Swarms of *Noctiluca miliaris* were observed in the summer months April-June, in the second week of August and in the third week of September. Species of *Ceratium* were occurring in small numbers throughout the year.

Zooplankton increases in the monsoon months June to September. Usually copepods predominate and species of *Paracalanus, Canthocalanus, Acrocalanus, Eucalanus, Calanopia, Acartia, Temora, Candacia, Labidocera, Pontella, Corycaeus, Oithona, Euterpina* and *Microsetella* are commonly met with. The cladocerans occurred in good numbers in May, October and December. The crustacean larvae including nauplii, Penaeid larvae and other decapod larvae were common throughout the year. The occurrence of *Lucifer reynoldii* was confined to the summer months of April–June and also to August.

Chaetognaths, appendicularians and doliolids were occurring regularly and the coelenterates were sporadic in appearance. The occurrence of bivalve veligers was carefully studied in view of the importance of the area under study. The veligers were provisionally classified into three types based on their shape and size, and their numbers were estimated in the samples. It was observed that during the year under report they were considerably poor in all the samples, whereas in March 1961 their numbers reached a peak. It may be of interest to note here that the surveys carried out so far have revealed a decline in the number of full-grown oysters in the nearby pearl beds.

Experiments using the dark and clear bottle method to evaluate the primary production in the inshore fishing areas off Tuticorin were undertaken during the second half of this year in selected stations. The results obtained so far indicated production up to 0· 649 gm.C./m.^{3}/day in the surface waters. C^{14} experiments conducted off Tuticorin yielded very interesting results. Beyond the 25 fm. line, highest rate of 253 mgC./m.^{3}/day was found at 10 metres and the depth of the photosynthetic zone was over 45 metres. This would amount to a daily rate of about 6 gC./m.^{2} which is remarkably high. The trawling grounds of Pinnakayal, near Tiruchendur, were also found to be fairly productive.

At Madras.—As during the previous year, work on all aspects on the plankton of the coastal waters off Madras was in progress during the year. The data show that the values were of a higher order during the year 1961–62

compared with 1960–61. The maxima and minima for the occurrence of the respective plankton elements were generally as follows:

	Predominantly phytoplankters	Mixed micro-plankters	Predominantly zooplankters	Macro-plankters
Maximum	July–August	August	August	June
Minimum	February–March	February	February	February

The above-mentioned data are at variance with those of the previous year.

Some work has also been done on the fluctuation in the fat content of the standing crop of plankton as well as on the iron-content of the water.

2. *Hydrology*

At Kandla.—During the year hydrological data for Kandla, Mundra, Modhwa, Adesar Camp and Surbari Camp were collected:

Month and year	Phos-phates μg.at./L.	Nitrite μg.at./L.	Sili-cate μg.at./L.	Oxygen c.c./L.	Sali-nity ‰	Temper-ature °C.	pH	No. of samples
1961								
April ..	0·792	0·320	18·42	5·381	41·88	25·56	8·03	3
May ..	0·465	No data	18·65	No data	41·35	28·25	8·20	4
June ..	0·570	No data	19·65	4·946	39·36	29·05	8·30	2
July ..	0·705	0·203	29·01	4·751	25·66	29·06	8·40	3
August ..	0·733	0·175	29·06	5·095	25·60	28·20	8·65	4
September ..	0·751	0·223	25·82	4·755	26·71	28·58	8·70	5
October ..	0·638	0·306	19·46	4·861	25·40	26·10	8·63	4
November ..	1·517	0·746	15·803	5·267	32·63	22·10	8·40	3
December ..	1·057	0·175	18·94	5·531	34·93	18·75	8·40	4
1962								
January ..	0·815	0·184	17·16	5·428	35·38	16·50	8·40	4
February ..	0·833	0·233	14·71	5·118	36·43	18·10	8·4	4
March ..	0·790	0·223	12·72	4·649	37·31	19·16	8·5	3

Month and year	Phosphates µg.at./L.	Nitrite µg.at./L.	Silicate µg.at./L.	Oxygen c.c./L.	Salinity %	Temperature °C.	pH	No. of samples
			Mundra Centre					
1961								
April ..	0·300	0·210	13·89	5·418	38·86	28·5	8·3	
May ..	0·830	Nil	16·60	No data	41·24	28·0	8·4	
June ..	0·660	Nil	12·00	No data	38·53	28·6	8·2	
July ..				No sample				
August ..	0·055	0·115	41·66	4·397	35·75	27·9	8·7	L
September ..	0·510	0·040	20·41	4·397	36·71	29·0	8·5	L
October ..	0·420	0·310	21·74	4·946	33·33	29·0	8·7	L
November ..	0·230	Nil	07·80	4·946	37·58	22·5	8·5	L
December ..	0·556	0·180	07·00	5·359	34·60	19·5	8·0	H
1962								
January ..	0·676	0·275	15·15	5·222	36·18	18·5	7·9	H
February ..	0·360	0·190	22·22	4·741	39·00	18·9	8·5	L
March ..	0·400	Nil	07·20	5·084	35·76	25·9	8·6	H
			Modhwa Centre					
1961								
April ..	0·610	0·150	16·67	5·428	42·86	24·8	8·1	
May ..	1·500	Nil	16·60	No data	43·67	25·9	8·2	
June ..				No sample				
July ..				No sample				
August ..	1·700	0·200	20·00	4·809	32·99	27·5	8·6	
September ..	0·610	Nil	20·83	5·153	27·68	26·5	8·6	
October ..	0·260	Nil	11·90	5·496	34·40	26·9	8·7	
November ..				No sample				
December ..	0·926	Nil	05·70	6·459	35·99	18·9	8·1	
1962								
January ..	0·943	0·190	11·11	6·733	31·82	16·9	7·9	
February ..	2·500	0·140	13·51	6·463	34·18	19·0	8·1	
March ..	0·833	0·130	07·40	5·496	35·77	19·2	8·5	
			Adesar Centre					
1961								
April ..				No sample				
May ..				No sample				
June ..				No sample				
July ..				No sample				
August ..				No sample				
September ..	0·230	Nil	55·55	5·428	03·25	29·5	8·6	
October ..				No sample				
November ..				No sample				
December ..	0·300	Nil	40·00	6·733	04·51	19·4	8·9	
1962								
January ..	0·190	0·100	41·67	7·872	05·08	15·6	8·9	
February ..	0·420	Nil	41·67	5·997	07·46	18·0	8·5	
March ..	0·195	Nil	12·50	4·946	10·63	22·9	8·5	

Month and year	*Surbari Centre* Salinity	Temperature °C.	pH
1961			
April	..	28·4	8·1
July	27·84	29·3	8·6
August	12·43	27·9	8·6
September	13·3	28·0	8·6
October	15·78	26·1	8·6
1962			
February	43·44	18·9	8·6
March	42·86	25·0	8·5

At Karwar.—Temperature was low during South-West monsoon and then in December–February. pH and salinity were low during the period of South-West monsoon. As usual, the influence of freshwater was more in the North than in the South. This year there was heavy rainfall. The salinity came as low as 0·47‰ and it is much lower than the values of the previous years. By the end of the year all these characters registered very high values. Salinity showed high figures when compared to the two previous years. The change from the low values of monsoon period to the high ones of the summer months usually takes place in a moderate pace and there exists a transition period during September–January when moderate temperature, pH and salinity prevail in the inshore waters. It is during this period that mackerel appear in schools along the coastline. This year this transition period was too short and it existed only in late October and early November and only during this time there was a poor fishery of mackerel. This may probably explain the failure of mackerel fishery along this coast during this year. Dissolved oxygen, phosphates and silicates were high during the rainy season. Silicate contents were more towards the south this year. Values of nitrites were generally poor except some rise here and there.

At Mangalore.—Sea-water samples were regularly collected once a week from 4 fm. area off Ullal. No samples could be collected at this place from the middle of May to the middle of September due to rough sea.

In April the average surface sea-water temperature was 29·6° C. which dropped to 29·1° C. towards the middle of May, but during the corresponding period of the last year these values were comparatively high. The lowest average temperature 26·6° C. for the year was accorded in September and this was also the same in the previous year. From October to December the average temperature was fluctuating between 28·1° C. to 28·3° C. However it dropped to 27·1° C. in January 1962 and gradually increased in February and March. In the middle of March, the highest temperature 30·6° C. for the year was recorded. The average sea-water temperature for January–March period of this year was lower than the corresponding period of last year.

The average salinity increased from 32·33‰ in April to 34·37‰ in May and the corresponding values of these two months of the last year were 33·46‰ and 32·14‰ respectively. The lowest salinity 9·96‰ for the year, was recorded in September and in the last year during this month it was 3·35‰ only. Sudden rise in salinity was observed from September to October, *i.e.*, from 13·33–28·12‰ and from then on to March salinity showed an upward trend. In the middle of February the highest value 36·49‰ for the year was recorded.

It is interesting to record here that temperature and salinity were steadily increasing from September to March and during this period heavy catches of oil sardine were made surpassing the catches of the last four years at Ullal.

There was no marked departure in pH as compared to the last year. pH value for April was 8·4 which dropped to 8·2 in March. In September, pH was 8·2 which gradually increased to 8·6 in November and dropped to 8·5 in December. The reading for January 1962 was 8·4 and for February and March it was 8·3 only.

At Cannanore.—Heavy monsoon rains started by the middle of the first quarter and large fluctuations in the salinity were observed (lowest 18·27‰ in July and highest 35·8‰). The water temperature also fluctuated more or less in unison with the salinity. The characteristic minor trough observed every year during October and November was not conspicuous, perhaps due to the poor N.-E. monsoon.

At Calicut.—Studies on the seasonal changes in the hydrological factors of the inshore and offshore waters were continued. The surface temperature of the inshore waters were generally higher in March and lower in July and August. Temperature of the offshore waters was highest in May and lowest in January.

Surface salinity of the inshore area was comparatively higher in May, February and March and lower from July to October. Bottom salinity was higher in May and October, to March and lower in June and July. Surface and bottom salinity of the offshore waters were highest in May and lowest in January.

Surface oxygen of the inshore region was higher in July and September and lower in May and June; bottom oxygen was higher from January to March and lower from July to October. Bottom oxygen of the offshore area was high in May and January and low in February and March. Surface values showed little variation in May and from January to March, being between 4·27 c.c./L. and 4·46 c.c./L.

Surface pH of the inshore waters was highest in May, June, October and January to February and lower in July and August; bottom pH was high from January to March and lower from July to October. Surface and bottom pH of the offshore waters was high in February. Low values of surface pH were in May and March and for bottom pH in May.

Surface and bottom silicates of the inshore environment were usually more from June to September and less from January to March. Silicates of the offshore waters were highest in May and lowest in March.

Surface and bottom nitrites of the inshore waters were higher from May to July and in September and October for surface layer and January to March for the bottom layer. Surface nitrites of the offshore waters were generally very poor during the period of observation (May and January to March); bottom nitrites were highest in May and lowest in January.

Surface total phosphorus of the inshore environment was higher in August and February and lowest in June, July and September; bottom phosphorus was high in July, August and February and low in May and January. Phosphorus of the offshore region was lowest in May and highest in February.

In general the salinity and the nutrient content (excepting silicates during the period June to October) of the bottom waters of the inshore area were found to be higher than those of surface waters. pH was in general lower in bottom waters. Dissolved oxygen of the surface layer was higher than at bottom during May, and July to October and lower in June and January compared to March period.

TABLE I

	Inshore waters (May 1961 to March 1962)		Offshore waters (May and January to March)	
	Range of average values			
	Surface	Bottom	Surface	Bottom
Temperature in °C.	25·1 (in Aug.) to 29·2 (in March)	..	28·2 (in Jan.) to 29·9 (in May)	..
Salinity ‰	18·78 (in July) to 34·92 (in May)	32·67 (in June) to 35·28 (in May)	33·59 (in Jan.) to 34·65 (in May)	33·67 (in Jan.) to 35·28 (in May)
Oxygen c.c./L.	3·59 (in June) to 4·51 (in July)	1·13 (in Aug.) to 4·80 (in Jan.)	4·27 (in May) to 4·46 (in Feb.)	4·34 (in March) to 4·80 (in May)
pH	8·2 (in July) to 8·72 (in Jan.)	8·13 (in Aug.) to 8·7 (in Jan.)	8·6 (in May and March) to 8·73 (in Feb.)	8·5 (in May) to 8·73 (in Feb.)
Phosphate P in μg.at./L.	0·4523 (in June) to 1·274 (in Aug.)	0·6153 (in May) to 2·143 (in Aug.)	0·2587 (in May) to 0·3393 (in Jan.)	0·4428 (in Jan.) to 0·8510 (in May)
Silicate Si in μg.at./L.	5·29 (in March) to 66·71 (in July)	7·18 (in Jan.) to 27·51 (in Aug.)	2·38 (in March) to 9·07 (in May)	4·82 (in March) to 10·44 (in May)
Nitrite–N in μg.at./L.	0·0203 (in Sep.) to 0·66 (in July)	0·0627 (in Sep.) to 2·144 (in July)	Nil (in May and March) to 0·130 (in Jan.)	0·064 (in Mar.) to 0·851 (in Feb.)
Total phosphorus in μg.at./L.	1·695 (in June) to 3·687 (in Aug.)	1·998 (in Jan.) to 5·128 (in Aug.)	1·218 (in May) to 3·421 in (Feb.)	1·978 (in May) to 3·939 (in Feb.)

Comparing the trends of the hydrological factors of the inshore and offshore waters during the months May and January to March, the temperature, salinity, pH and surface oxygen of the offshore waters were generally higher than inshore waters. Bottom oxygen of the offshore waters was higher than those of inshore waters during the months May and February and lower in January and March. Nutrient concentration was always higher in inshore waters.

The results of the analyses of the inshore muds and overlying water are shown in the following tables.

Mud

	Range of average values
Temperature °C.	.. 24·1 (in August and September to 29·3 (in March)
Moisture %	67·44 (in March) to 70·32 (in August)
Silt %	80·92 (in March) to 93·97 (in October)
pH	7·2 (in March) to 8·1 (in August)
Total phosphates P in μg. per g. of silt	987 (in September) to 1719 (in August)
Inter silt phosphates P in μg./g. of mud	82 (in February) to 121 (in January)
Adsorbed phosphates P in μg./g. of silt	129 (in January) to 88 (in February)
Total nitrogen in mg./g. of silt	2·54 (in October) to 4·57 (in March)
Total iron in mg./g. of silt	52·51 (in October) to 82·79 (in February)
Organic carbon %	2·54 (in October) to 3·95 (in January)

Overlying water of the mud
(bottom layer)

	Range of average values
Temperature °C.	23·9 (in September) to 29·3 (in March)
Salinity ‰	33·93 (in October) to 34·41 (in September)
pH	8·1 (in August and September to 8·7 (in February)
Oxygen c.c./L.	2·23 (in September) to 4·67 (in January)
Inorganic phosphates in μg.at./L.	0·7878 (in January) to 2·955 (in September)
Total phosphorus in μg.at./L.	3·000 (in January) to 4·075 (in September)

In general the nutrient content of the mud was higher in August and January and lower in September and February, whereas that of overlying water it was higher in August and September and lower in October and January.

At Ernakulam.—There were no research cruises of Kalava after April owing to the onset of monsoon and the consequent rough weather. With the arrival of the new research vessel *Varuna*, cruises commenced from December 1961. The first one was to Laccadives during which 3 sections and water samplings down to 2,000 metres were made. In the cruises from January 1962 onwards, the entire area of shelf and deeper waters along the west coast of India from 7–15° N. latitude has been covered.

During the period prior to *Varuna* cruises, the data collected in the previous *Kalava* cruises the processing of which had not been completed, were taken up and the detailed analysis was carried out. The following aspects were investigated in greater detail:

(i) Main hydrological features during the summer of 1961 along the entire coast up to 13° N.

(ii) Vertical distribution pattern of dissolved oxygen along the entire Kerala coast during the season of 1959–60.

(iii) Frequency distribution of temperature and salinity in the whole area down to a depth of 500 meters. The main points arising out of these studies are presented in this report.

(i) 1961 *Summer conditions.*—The surface temperature ranged between 29·15° and 29·68° C. A rise to 30·2° C. is seen during midsummer, but the high value lasted only for a very short time. The near-shore waters were found to be slightly cooler than the waters beyond the shelf. The difference between the coastal and offshore temperatures was seen to be 0·5° C. The waters were more or less isothermal down to 30 m. Between 30 and 75 m. there is a reduction by nearly 0·85° C. A well-defined thermocline was seen to be present between 80 and 120 m. which is typical of stable summer conditions. The surface salinity values varied from 34·97‰ nearer shore to 34·63‰ beyond the shelf a variation or gradient of 0·34‰ over a distance of 60 miles. A well-defined salinity maximum was found at 100 m. A comparison with the data for the summer of 1960 shows that while the temperature distribution has attained slightly higher values as compared with the previous year, the T-S relationships are slightly affected by this, but not to any marked extent.

(ii) The main features in the vertical distribution pattern of dissolved oxygen are as follows:

In the waters north of Cochin up to Mangalore (which have been studied during the stable summer period) the values show a good degree of oxygenation—in most cases above 85% saturation. Between Cochin and Kozhikode in the 20–30 fm. area, there is almost a distinct tongue of high-oxygen water extending from surface down to bottom. From the shore up to about 15 miles this is not seen, although the oxygen content here is also fairly high. North of Kozhikode this high oxygen column has spread over a wider area, covering the entire shelf commencing right from the shore. A distinct oxygen-maximum layer has been formed in the deeper waters beyond the shelf, between 20 and 40 fm. in the area between Kozhikode and Cannanore. The oxygen-minima are seen only in the waters beyond the shelf at the 150–200 m. level.

For the waters south of Cochin, the data are available only for the month of December during that year. The most interesting feature is the convergence of the iso-oxygen lines on the shelf (almost like pouring, as it were, from the offshore area). This results in the shelf getting well oxygenated, while beyond the shelf even at about 50 m. very low oxygen values are seen. These results are characteristic of the period of sinking. The isopleths for oxygen and temperature seem to almost coincide.

(iii) The frequency analysis of the temperature-salinity parameters for the period December 1959 to April 1960 shows that the dominant water types in this region have the temperature range 28–29° C. and two salinity ranges of equal significance: 34·8–35·2‰ and 34·0–34·4‰, the former usually characteristic of sub-surface waters. This type of frequency analysis may be helpful to detect any abnormal change in the environment.

A preliminary study of the T-S characteristics of the waters around Laccadives and waters in between Minicoy to Cochin has shown that the characteristics of water masses in the Laccadives area below 100 m. depth are same at all the stations, but the upper 100 m. layer shows some variations from station to station. However, these variations are not of basic character and they can be attributed to the local factors. Waters in between Minicoy and Cochin show two distinct water masses in the upper 150 m. layer. A strong current from about 70 miles away from Minicoy has separated these water masses. The water mass towards the coast shows close resemblance with the water mass occurring around Laccadives while the water mass towards Minicoy is essentially different. Below the depth of 150 m., however, same water exists.

Thermal and salinity distribution off the West Coast of India from Mangalore to Cape Comorin during 3rd January to 9th March 1962 indicate surface temperature over the entire coast varies from 26·90–29·81° C. The distribution of surface temperature shows that by the first week of January offshore water is warmer than the inshore water. Surface temperature in area north of Cochin is almost uniform while that south of Cochin shows fluctuations. Higher surface temperature is recorded towards the southern sector. With the passage of time, there is a gradual rise in surface temperature, and waters north of Cochin retain uniform temperature. However, during the second week of February the above distribution is reversed. Higher temperature is observed towards the northern coast off Mangalore and a small strip of cold water seems to be flowing along the coast. Beyond this strip wider fluctuations occur towards north, especially off Mangalore and Kovvayi than towards south off Cranganore is suggested. The possibility of thermal eddy north of Cranganore. The pattern of distribution of surface temperature in general with some obvious variations seems to continue till the 10th of March.

Sub-surface temperature during the entire period is slightly higher than the surface temperature in general. The depth at which it occurs varies from 20–75 m. Generally, a uniform upper layer varying from 20–50 m. but, mostly of 30 m., is found with a little temperature variation and from thence onwards there may be a slight rise up to a maximum value in temperature. Below this depth range there is a gradual fall of temperature. The fluctuations of sub-surface depths and the values of temperature follows the pattern of surface temperature distribution quite closely. The temperature at 100 m. depth varies widely in the beginning of January towards the northern areas off Kozhikode to Cochin, but, gradually temperature differences at this depth are decreased. From very unstable layer a trend towards stability at this depth is observed. Later at 100 m. depth off Alleppey, Kayamkulam, Kayal, Trivandrum and Cape Comorin, instability is observed.

Surface salinity varies from 33·15–35·53‰. The distribution of surface salinity is very much akin to the distribution of surface temperature. Higher saline water is observed offshore and towards south, with nearly uniform surface salinity values over the continental shelf area in between Cochin to Kozhikode by the beginning of January.

At the beginning of January maximum salinity around 36·30 + 0·30‰ occurs at 75 m. depth. Later the depth is further lowered to 100 m. and occasionally to 150 m. and more fluctuations in values of salinity occur by the end of the third week of February, especially towards north, off Cannanore.

However, very slight fluctuation in salinity value occurs off Cape Comorin and Trivandrum by the end of the 1st week of March. Salinities at depths greater than 200 m. show a little variation.

Except for the monsoon and post-monsoon period (up to October), surface temperature distribution was more or less uniform in the area around the Willingdon Island. The differences in the temperatures of the surface and bottom waters were most marked during the monsoon and post-monsoon. Particularly during August, September and early October, the bottom temperature generally attained low values. By December and January, the bottom temperature began to increase.

The surface salinity which was usually very low during June to September and even early October had shown a distinct rise by December to 25–30‰ and by February the values reached 32‰ level. The bottom salinities ranged between 30 and 33‰ throughout the year.

In the case of dissolved oxygen content of the backwaters, there was a distinct stratification in the monsoon and post-monsoon months, with the bottom water showing very low oxygen values. By the end of October the stratification had disappeared.

At Tuticorin.—The physico-chemical conditions of the sea-waters in the pearl bank area were studied. The surface temperatures fluctuated from 27·5–30·7° C. during April–June; 27·5–28·5° C. during July–September; 25·0–30·1° C. during October–December and 26·0–29·0° C. during the last quarter. As during last year low temperatures were recorded in the months of November and December and high temperatures in the month of May. The pH values did not vary very much and ranged from 8·2–8·5. The salinity normally varied from 33·0–35·0‰. But a slightly low value of 28·74‰ was recorded during a particular week in the second quarter. This was after a spell of heavy rainfall in the neighbouring areas and the consequent influx of rain-water. The dissolved oxygen content in the surface-waters ranged from 4·0–5·6 c.c./l. As regards the nutrient salts, the inorganic phosphates ranged from nil values to 2·5 μg. at P/l. and silicates from nil values to 25 μg. at Si/l.

3. *Bottom Fauna*

At Cannanore.—With the commencement of the monsoon, there was complete depletion of inshore bottom fauna. The bottom mud became very loose and remained so till November. The recolonisation of inshore bottom was slow and delayed due to the non-settling of mud at the appro-

priate period. Only during the last quarter was the inshore bottom recolonised. Chaetopterid, nereid and other polychaetes and pholadid bivalves, and certain species of cumaceans have settled well at the bottom. The juvenile soles were found to feed actively on them. Amphipods and nemertines and very young prawns are also encountered. The late settling of the inshore bottom mud may be one of the reasons for the late and sparsely distributed sole fishery during this year. There were no mud banks or mud flats formed at Cannanore although there were lucrative mud bank fisheries of soles, prawns and sciaenids near Tellicherry and near Kasargode.

At Kozhikode.—Studies on the bottom fauna and bottom plankton off Kozhikode in relation to the feeding of bottom fishes have been continued during the year.

But for the noticeable abundance of *Disoma* at Vellayil on 4 April, the bottom fauna in the pre-monsoonic period has been poor, *Ancistrosyllis constricta*, *Diopatra*, *Lumbiconereis bifilaris*, *Phyllochaetopterus*, *Magelona*, *Nephthys*, *Sabellaria*, gastropods, lamellibranchs, actinaria and hermit crabs being represented in small numbers. For several months during the post-monsoonic season the bottom mud was 'liquidy' and colonisation on this unfavourable substratum was poor. Representatives of the following organisms were found during this period: *L. bifilaris*, *Nephthys*, pilargiidae, *Phyllochaetopterus*, *Clymene*, *Prionospio pinnata*, abranchiate cirrarulidae (? *Cossura delta*) *Magelona*, *Diopatra*, *Polydora*, *Nereis*, hydroids, bryozoans, *Cavernularia*, sipunculoidea hermit crabs, *Turritella antennata*, *Modiolus*, Pholadidae, *Mactra*, *Umbonium* and Nuculanidae. By the first week of February the bottom mud was of a semi-solid consistency and colonisation during this period was markedly denser, *Disoma*, *Dioptra*, *Clymene*, *Pectinaria* and *Cheiriphotis megachelis* forming the chief organisms. Hydroid colonies, bryozoa, *Ancistrosyllis constricta*, *Eteone*, *Nephthys*, glyceriidae, *Sabellides*, *L. bifilaris*, *Sternaspis*, *Eupolia*, Pycnogonidae and foraminifera were also found in good numbers, but *P. pinnata* and *P. cirrifera* were represented by only a few individuals in stray samples. *Disoma* has taken the place of *P. pinnata* in being the dominant member of the bottom fauna during the current year and *P. cirrifera* were represented by only a few individuals in stray samples.

Larval invertebrates were not abundant in the bottom plankton on any occasion during the year. Shelled veligers were common during the last week of August and during September; it is likely that these were the Nuculaniidae that appeared in the mud during September. Larval forms of Polynoidae,

Spinoidae, Nereidae, *Polydora*, *Sabellaria*, *P. pinnata* and actinaria have been occurring in small numbers on several occasions.

In the stomach of *Cynoglossus semifasciatus* the commonest organism found during the first quarter was *Phyllochaetopterus*. *Lumbriconereis bifilaris*, *Sternaspis*, *Clymene*, thin-shelled lamellibranchs (? *Laternula*) and *Coscinodiscus* were found during the 2nd and 3rd quarters. During the last quarter *Disoma* was the chief food of this fish, along with amphipods (*Cheiriphotis megacheles*), *L. bifilaris*, *Clymene* and *Diopatra*. These observations are in accordance with the earlier finding of "the dominant member of the fauna being usually the dominant member of the gut contents also." On rare occasions Malabar sole was found to feed on young *Squilla*. That the fish also uses feeding grounds other than those in which fished is indicated by the complete absence of *Disoma* in the stomachs during periods when this worm was abundant in the bottom mud (4th April and 16th March).

At Mandapam.—The studies on the bottom fauna of the Palk Bay inshore waters were commenced in 1961. The area selected for observation lies between 9° 17′ to 9° 21′ N. and 79° 07′ to 79° 10′ E. Fortnightly collections of water samples and the bottom fauna have been made from arbitrary stations I, II and III at a depth of 4, 8 and 11 m. respectively. The samples of water have been analysed and their temperature, oxygen, salinity and phosphate content have been recorded. The bottom deposits and their associated fauna were collected with the aid of Peterson's grab. It was observed that the collections made within 4 m. zone were not successful since the bottom consists of pieces of dead corals and shingles. The bottom at a depth of 8 and 11 m. consists of soft clay and harbours a richer fauna than the shallower zones. Especially the polychaete fauna is rich in deeper zones. Further studies on the density of population, their seasonal abundance and fluctuations are in progress.

4. *Algology*

At Mandapam.—Taxonomic and ecological studies of algae of the intertidal zone were continued and during the period under review, the *Gracilaria* beds near Hare Island were examined. These beds were in very good condition, dominated by *Gracilaria edulis*, *Hypnea valentiae* and *Cymodocea australis*. From these beds, 'cut' harvesting of *Gracilaria* is not possible due to the sandy-marsh substratum and only pulling out the plants is possible. A large area from this place is cleared in this manner to find out the time taken for recolonization by such a harvesting. This work is in progress.

During the month of December, a study of the algal beds of Gujarat and Maharashtra coasts was undertaken. In the Gujarat zone, the only agaroid weed worth exploiting is *Gelidium micropterum* which alga is found in the intertidal zone intermingled with *Ulva* and *Enteromorpha*. Other agaroid-weeds were few, though muscilagenous red forms were common. Around Bombay only Sargassums and Enteromorphas were in fairly good condition.

Sorting of the herbaria of the Institute is completed and identification of these is in progress.

CENTRAL MARINE FISHERIES
RESEARCH INSTITUTE,
Marine Fisheries Post,
Mandapam Camp (S. India),
March 31, 1962.

S. JONES,
Director.

V. LIST OF PUBLICATIONS

1. GEORGE, K. C. 1960. On a new Gastrocotylid trematode, *Engraulicola forcipopenis* gen. *et* sp. nov. on a white-bait, from Southern India. *J. Mar. biol. Ass. India*, **2** (2), 208–15.

2. JAMES, P. S. B. R. 1960. Instances of excessive thickening of certain bones in the ribbon fish, *Trichiurus lepturus* Linnaeus. *Ibid.*, **2** (2), 253–58.

3. JONES, S. 1960. Notes on eggs, larvae and juveniles of fishes from Indian waters. VI. Genus *Auxis* Cuvier, VII. *Sarda orientalis* (Temminck and Schlegel). *Indian J. Fish.* **7** (2), 337–47.

4. ———. 1960. Notes—Further notes on *Spartelloides delicatulus* (Bennett) as a tuna live-bait fish with a record of *S. japonicus* (Houttuyn) from the Laccadive Sea. *J. Mar. Biol. Ass. India*, **2** (2), 267–68.

5. —— AND SANKARANKUTTY, C. 1960. Notes on animal associations. III. A parthenopid crab, *Harrovia albolineata* Adams and White, on a mariametrid crinoid, *Lamprometra* sp. *Ibid.*, **2** (2), 194–95.

6. —— AND SILAS, E. G. 1960. Indian tunas—A preliminary review, with a key for their identification. *Indian J. Fish.*, **7** (2), 369–93.

7. KAIKINI, A. S. 1960. The fishes of Malwan. *Ibid.*, **7** (2), 348–68.

8. KAMASASTRI, P. V. 1960. Studies on the Indian Sardine oil. *Ibid.*, **7** (2), 443–47.

9. NAGABHUSHANAM, A. K. 1960. Notes—Observations on some pelagic tunicates in coastal waters of the Bay of Bengal. *J. Mar. biol. Ass. India*, **2** (2), 263–64.

10. NAIR, P. V. R. 1960. On two diatoms from the inshore waters of Palk Bay. *Ibid.*, **2** (2), 194–95.

11. PRASAD, R. R. AND NAIR, P. V. R. 1960. Observations on the distribution and occurrence of diatoms in the inshore waters of the Gulf of Mannar and Palk Bay. *Indian J. Fish.*, **7** (1), 49–68.

12. —— AND TAMPI, P. R. S. 1960. Phyllosomas of scyllarid lobsters from the Arabian Sea. *J. Mar. biol. Ass. India*, **2** (2), 241–49.

13. ————. 1960. On the newly hatched phyllosoma of *Scyllarus sordidus* (Stimpson). *Ibid.*, **2** (2), 250–52.

14. RAMAMRITHAM, C. P. AND JAYARAMAN, R. 1960. Hydrographical features of the continental shelf waters off Cochin during the years 1958 and 1959. *Ibid.*, **2** (2), 199–207.

15. RAMASASTRY, A. A. AND RAMAMRITHAM, C. P. 1960. Velocity of sound in the Arabian Sea along the South Malabar Coast during the post-monsoon season. *Indian J. Fish.*, **7** (2), 394–406.

16. SILAS, E. G. 1961. Miscellaneous note. II. Occurrence of the sea cow, *Halicore Dugong* (Erxl) off the Saurashtra Coast. *J. Bombay Nat. Hist. Soc.*, **58** (1), 263–65.

17. —— AND DAWSON, E. 1961. Miscellaneous note XVI. *Heteropneustes fossilis* (Bloch), a new addition to the freshwater fish fauna of the Andaman Islands. *Ibid.*, **58** (1), 287–89.

18. ————. 1961. *Amphipnous indicus*, a new synbranchoid eel from India with a redefinition of the genus and a synopsis to the species of *Amphipnous muller*. *Ibid.*, **58** (2), 366–78.

19. SILAS, E. G. AND PILLAY, C. K. 1960. The stranding of two false killer whales [*Pseudorca crassidens* (Owen)] at Pozhikara, north of Cape-Comorin. *J. Mar. Biol. Ass. India*, **2** (2), 268–71.

20. —— AND SANKARANKUTTY, C. 1960. On the Castle building habit of the Crab *Cardisoma carnifex* (Herlest) family Geocarcinidae, of the Andaman Islands. *Ibid.*, **2** (2), 237–40.

21. SUBRAHMANYAN, R. AND VISWANATHA SARMA, A. H. 1960. Studies on the phytoplankton of the West Coast of India. III. Seasonal variation of the phytoplanktèrs and environmental factors. *Indian J. Fish.*, **7** (2), 307–36.

22. UMMERKUTTY, A. N. P. 1960. Studies on Indian copepods II. An account of the morphology and life-history of a Harpacticoid Copepod, *Tisbintra jonesi* sp. nov. from the Gulf of Mannar. *J. Mar. biol. Ass. India*, **2** (2), 151–64.

23. ——. 1960. Studies on Indian Copepods. III. *Nearchinotodelphis indicus*, a new genus and species of Archinotodelphyid copepod from Indian Seas. *Ibid.*, **2** (2), 165–78.

24. ——. 1960. Studies on Indian Copepods. IV. Description of the female and a redescription of the male of *Pseudodiaptomus ardjuna* Brehm. (Copepoda, calanoida) with notes on the distribution and affinities of the species. *Ibid.*, **2** (2), 179–85.

25. VARMA, R. P. 1960. Flora of the pearl beds off Tuticorin. *Ibid.*, **2** (2), 221–25.

26. VENKATARAMAN, G. 1960. Studies on the food and feeding relationships of the inshore fishes off Calicut on the Malabar Coast. *Indian J. Fish.*, **7** (2), 275–306.